"A STUDY ON THE GREAT SAPHENOUS VEIN" INCLUDING IT'S SURGICAL AND RADIOLOGICAL IMPLICATIONS

Submitted in partial fulfillment for

M.S. DEGREE EXAMINATION
BRANCH – V ANATOMY

Upgraded Institute of Anatomy

Madras Medical College & Research Institute,
Chennai

THE TAMIL NADU Dr.M.G.R. MEDICAL UNIVERSITY
CHENNAI – 600 003
TAMIL NADU

MARCH – 2008

CERTIFICATE

This is to certify that the Dissertation on "A study on the **Great Saphenous vein** including it's surgical and radiological implications", is a bonafide work, carried out in the Upgraded Institute of Anatomy, Madras Medical College, Chennai – 600 003, during 2005 – 2008 by **Dr. T. Preethi Ramya**, under my supervision and guidance in partial fulfillment of the regulation laid down by The Tamil Nadu Dr. M.G.R. Medical University, M.S. Anatomy Branch – V Degree Examination to be held in March 2008.

DEAN
Madras Medical College
Chennai – 600 003.

Prof. Dr. CHRISTILDA FELICIA JEBAKANI, M.S.,
Director & Professor,
Upgraded Institute of Anatomy,
Madras Medical College,
Chennai – 600 003.

Date :

Station :

Date :

Station :

ACKNOWLEDGEMENT

I sincerely express my gratitude and indebtedness to my most respected teacher and guide **Dr. CHRISTILDA FELICIA JEBAKANI, M.S.,** Director and Professor, Upgraded Institute of Anatomy, Madras Medical College, who has motivated me to perform this study and provided her valuable guidance and facilities available in the institute for my study.

I earnestly thank **Dr. T.P. KALANITHI M.D.,** Dean, Madras Medical College, Chennai for permitting me to avail the facilities in the institution for my study.

My gratefulness to **Dr. T.S. SWAMINATHAN M.D., D.M.R.D** Professor and Head of the Department, Barnaud Institute of Radiology, Madras Medical College, Chennai for his help in radiological study.

I express my thanks to **Dr. K SARASWATHI M.D** Director and superintendent, Institute of Obstetrics and Gynecology, Egmore, Chennai for helping in foetal study.

I express my thanks to **Dr T. VIDYA SAGARAN M.S.M.ch.** Professor and Head of the Department, Vascular Surgery, Madras Medical College, Chennai for his support in specimen collection.

I sincerely thank **Tmt. M.S. THENMOZHI, Dr. I. JEYARAJ, M.S., Dr. B.CHEZHIAN, M.S., Dr. V.LOGANAYAKI, M.S., D.O., Dr. V. SATHYALAKSHMI, M.S., Dr. M. VIJAYALAKSHMI. M.S.,** Assistant Professors, and also Tutors of Institute of Anatomy, Madras Medical College, Chennai for their valuable support.

I thank my colleagues for their support. I also thank my juniors **Dr. SUDHA, Dr. MUKUNDAN,** and **Dr. RAJAPRIYA** and all my colleagues for their kind co-operation and their support. I also thank **Dr. KARTHIK SENTHIL RAJA** for his help.

I thank **Dr. DEEPTI SHASTRI** for guiding me in this study.

I am thankful to the technicians and all other staff members for helping me in sectioning and preserving the specimens.

I am most grateful to my husband **Er. SAM, Grandma, Parents, Parents-in-law, Dr. Sheela, Dr Suguna, Dr Priya,** who made this study a reality.

And above all I thank **GOD ALMIGHTY.**

CONTENTS

INTRODUCTION

The veins of the lower extremity are divided into deep and superficial veins. The Superficial veins of the lower extremity begin in the foot and form two chief channels running up the leg, the Great or Greater (long) Saphenous vein and the Small or Lesser (short) Saphenous vein.

The word **Saphenous** is derived from Greek origin meaning visible.

The Literature of the earlier dates mention this vein as **Internal Saphenous vein.**

Majority of the Great Saphenous Vein is formed as the continuation of the medial end of the dorsal venous arch. The tributaries of the Great Saphenous veins are likened the most constant to two inverted tridents, one below the knee and one at the groin.

Below the knee, the anterior superficial tibial and posterior arch veins enter the Great Saphenous Vein at approximately same level. The Posterior crural arch vein was first illustrated by **Leonardo da vinci** and his name is applied to the veins in surgical circles. Other tributaries in the leg are infra genicular vein and Inter-Saphenous vein.

At the groin, the two largest and most important tributaries are the antero-lateral and postero-medial veins of the thigh.

The antero-lateral tributary has apparently been called as **Lateral Accessory Saphenous Vein**, External superficial femoral vein, Lateral femoral circumflex vein, Anterior saphenous vein and Accessory saphenous vein.

The postero-medial tributary has been called as **Medial Accessory Saphenous Vein,** Internal femoral cutaneous vein, Medial superficial femoral vein, Medial femoral circumflex vein, Posterior saphenous vein.

Other tributaries of the Great Saphenous Vein are Superficial epigastric vein, Superficial circumflex iliac vein, Superficial external pudendal veins. Anatomic variants are common at this site.

The mode of union of these tributaries at Sapheno-femoral junction varies. The conventional type in a **"vein-star"** shape is the most frequent.

Variations with the relation to the Superficial external pudendal artery running in front of rather than behind, the great saphenous vein are quite common.

The perforators connecting the superficial veins with the deep veins include direct, indirect, mixed and atypical veins.

They are

i) Hunterian perforator

ii) Posterior tibial perforator

iii) Calf perforators

iv) Paraperoneal perforators

v) Medial ankle perforators

The use of great saphenous vein as a graft and its use as an alternative to dialysis make the study of the vein on its topographical arrangement and an account on the structure and the arrangement of valves of much importance.

AIM OF THE STUDY

Abnormalities and variation of veins are more frequently met with than those of arteries. The Long saphenous vein is the conduit of choice as a graft in femoro-distal and coronary artery bypass operations. The vein is also used for mitral annuloplasty. Great saphenous vein obtained from cadavers and preserved by lyophilization are an alternative source of venous allografts for arterial reconstructions.

When the great saphenous vein is used as an arterial graft, congenital narrowing, segmental hypoplasia and aplasia should be considered with respect to the caliber of the vein. Primitive narrowing of great saphenous vein segments has been described in healthy limbs.

Important variations in the Great saphenous vein are in relation to the veins entering it close to its upper end.

The appearance of varicosities after high ligation and stripping of the greater saphenous vein are said to be failure to ligate all the superficial veins, because of the variation in the region of the saphenous opening and failure to ligate incompetent perforators.

The great saphenous vein as it runs up close to the medial border of the tibia, where it is to be avoided in ligation of the posterior tibial artery to the back of the medial condyle the vessel is to be remembered in operation on the knee joint.

The upper segments of incompetent varicose veins apparently have fewer valves than do similar length of normal veins, suggests the paucity of valves as a factor in the etiology of varicose veins. The number and distribution of valves in the great saphenous vein should be taken into account while obtaining vein segments in graft operations.

Characterisation of the relationship between the superficial veins and nerve according to each part of lower limb reduces the risk of nerve injury during the stripping operation.

The ligation and stripping operations of great saphenous vein for varicosities and choosing a vein for grafting, needs a expert knowledge about the variations of the veins.

These reasons motivated me to make an effort to study the great saphenous vein. The study is done with the following parameters.

1) Formation of Great saphenous vein.

2) Length of Great saphenous vein.

3) Diameter of Great saphenous vein.

4) Level of termination.

5) Drainage pattern at Sapheno- Femoral Junction.

6) Relationship of Great Saphenous Vein with saphenous nerve and external pudendal artery .

7) Perforators.

8) Number of valves.

REVIEW OF LITERATURE

1. FORMATION OF GREAT SAPHENOUS VEIN.

Henry Gray (1858) 39th Edition, states the Great saphenous vein starts inferiorly as a continuation of the medial marginal vein which is formed by veins from more superficial parts of the sole. The dorsal venous arch connects with the medial marginal vein on the medial side.

Russel. T. Woodburne (1961) describes the Great saphenous vein as the longest vein of the body which begins at the junction of the medial end of the dorsal venous arch and the medial dorsal vein of the great toe.

Hollinshead (1961) said that the Great saphenous vein originates from the medial side of the dorsum of the foot.

Roger Warwick (1963) says the Long saphenous vein begins at the medial end of the dorsal venous arch of the foot.

G.J. Romanes (1964) quoted that the dorsal venous arch on the dorsum of the foot ends medially by uniting with the medial dorsal digital vein of the big toe to form the Great saphenous vein.

Gardener – Gray – O Rahilly (1986) stated that the Great saphenous begins at the junction of the dorsal digital vein of the medial side of the big toe with the dorsal venous arch.

M. Prives, N. Lysenkov, V. Bushkovich (1985) quoted that the Long saphenous vein originates on the dorsal surface of the foot from rete venosum dorsale pedis and the arcus venosus dorsalis pedis.

Ernest Gardener, Donald J. Gray, Ronan 'O' Rahilly (1967) has stated that the Great saphenous vein begins at the junction of the dorsal digital vein of the medial side of the big toe with the medial end of the dorsal venous arch.

Keith L. Moore (1980) stated that the Long saphenous vein begins at the medial end of the dorsal venous arch.

2. LENGTH OF THE GREAT SAPHENOUS VEIN.

N.J. Papadopoulos *, M.F. Sherif and E.N. Albert (1981) studied the length of Great saphenous vein in 30 embalmed human cadavers (19 male and 11 female).

This length was measured between two points of surgical importance, i.e., from the upper ridge of the medial malleolus to the sapheno-femoral junction. As an intermediate bony reference point, the easily palpable medial femoral epicondyle was used.

A. Length of the Great saphenous vein in the leg ranged between 31 and 37 cm having a mean of 34.5cm (34.9 cm in males and 33.8 cm in females)

B. Length of the Great saphenous vein in the thigh ranged between 30 and 37 cm having a mean of 34 cm (34.6 cm in males and 33.2 cm in females)

C. Total length of the Great saphenous vein ranged between 61 cm and 74 cm having mean of 68.6 cm (69.5 cm in males and 67.1 cm in females)

3. CALIBRE OF GREAT SAPHENOUS VEIN.

Charles Kosinski (1926) said that it is noteworthy that the calibre of the Great saphenous vein is often less at its termination than in the lower part of the leg.

Howard R. Mahorner, Alton Ochsner (1938) measured the diameter of the Great saphenous vein to be from 0 .5 to 2 cm.

L.T Cotton (1961) found a change in the calibre of the normal Long saphenous vein as the vein approaches the knee, but the change is very small. In varicose veins the long saphenous vein is cylindrically dilated in the upper part of the lower leg and thigh. In lower leg the Great saphenous vein is often normal in calibre. The change in caliber of vein is often abrupt and coincides with the point of entry of a large varicose tributary.

Caggiati A, Ricci.S (2000) Their study evaluated Long saphenous vein morphology in dissection of 32 cadaveric limbs. The long saphenous vein was constant in most of the limbs, showing only a mild and progressive increase

from the ankle to the groin. Further more, great individual variation in the Long saphenous vein calibre was found. A segmental narrowing of the Long saphenous vein was present in 39.8 % of limbs, out of which in 22.4 % of cases narrowing was visible by naked eye dissection or ultrasound and 17.4 % the calibre was so reduced and could be detected only microscopically.

4. LEVEL OF TERMINATION

Henry Gray (1858) 39th edition said that the so called centre of the saphenous opening is often said to be 2.5 cm – 3.5 cm infero lateral to the pubic tubercle.

George. A.Piersol (1930) said that the Great saphenous vein pierces the cribriform fascia at fossa ovalis and opens into femoral vein. He also quoted that the Great saphenous vein may perforate the fascia lata some distance below the fossa ovalis as one of the variations.

Howard. R.Mahorner, Alton Ochsner (1938) say that the fossa ovalis is located two finger breadths medial to Femoral artery and one finger breadth below poupart's ligament or below the level of spine or pubis.

Basmajian (1952) Mavor And Galloway (1967) mentioned an accurately defined point 3 to 4 cm below the middle of the inguinal ligament and 1.7 cm lateral to pubic tubercle as the saphenous opening through which the Great saphenous vein drains into Femoral vein.

Buchanan (1953) said that towards the proximal end of the thigh the Great saphenous vein inclines anteriorly and at a point about 1 ½ inches distal to the inguinal ligament it pierces the deep fascia (cribriform fascia) occupying the saphenous opening and ends by joining the Femoral vein.

Morris. (1953) quoted that Great saphenous vein runs on the medial side of the front of the thigh to about 3.7 cm below the inguinal ligament, where it dips through the fossa ovalis (saphenous opening) in the fascia lata, and ends in the femoral veins.

R.D.Lockhart, G.F.Hamilton, F.W.Fyfe (1959) According to them the Great saphenous vein pierces the cribriform fascia of the saphenous opening of the fascia lata and joins the Femoral vein just below the inguinal ligament, usually about one and a half inches below and lateral to the pubic tubercle. Occasionally it may enter the Femoral vein at a lower level in the thigh, the Femoral vein receiving some of the normal tributaries.

G.J.Romanes (1964) states that towards the upper end of the thigh Great saphenous vein inclines to the front of the limb, and at a point about 1 ½ inches below the inguinal ligament it passes backwards, traverses the cribriform fascia occupying the saphenous opening and the anterior wall of the femoral sheath, it finally ends by joining the Femoral vein.

J.P.Royle, R.Eisner (1981) performed flush ligations of Long saphenous vein in 136 patients for the treatment of varicosities during 9 month period. Of 167 dissections, 158 of the sapheno- femoral junction were found to be between 3 and 5 cm lateral to the pubic tubercle. In four sides the sapheno-femoral junction was found to be less than 3 cm and in five sides greater than 5 cm lateral to the pubic tubercle.

The sapheno-femoral junction was more than 1 cm below the pubic tubercle in 12 dissections .One hundred and fifty five sapheno-femoral junctions were within 1 cm of the pubic tubercle .In the remaining 13 sapheno-femoral junctions, 12 were found to be 2 ½ cm above the pubic tubercle.

Adb Ndiaye, J. Ndoye, O. Diarra, M. Diop, A. Dia, M. Ndiaye, M. Son (2005) In their dissections of 54 inguino femoral regions of fresh black african corpses, they found on average the top of the arch of Great saphenous vein was projected 10.88 cm from the ventral and cranial iliac spine, 3.83 cm from the pubic and 4.19 cm from the inguinal ligament.

5. DRAINAGE PATTERN AT SAPHENO - FEMORAL JUNCTION.

Henry Gray (1858) 39th edition, quoted that the periinguinal tributaries of the Great saphenous vein are superficial epigastric, superficial circumflex iliac and superficial external pudendal veins. Their mode of union varies. The deep external pudendal vein joins the Great saphenous vein in its opening.

George A. Piersol (1930) states that the Great saphenous vein receives, just before its entrance into the Femoral vein , a number of vessels which accompany the superficial branches of the Femoral artery. They are by no means constant tributaries of the saphenous vein, but frequently pass through the cribriform fascia to open directly into the Femoral vein.

External pudendal veins are two in number one superficial and one deep

The Superficial circumflex iliac vein frequently unites with superficial epigastric vein before opening into the Great saphenous vein.

The superficial epigastric vein at a varying level is joined by Thoraco epigastric vein. Thoraco epigastric vein is occasionally prolonged downward to open independently into the Great saphenous vein.

S. Thomas Glasser (1943) In his study, based on the dissection of fossa ovalis region of 100 lower extremities (50 cadavers) he demonstrated 19 sapheno femoral drainage patterns as shown in Table No 1.

TYPE - I

A. Superficial circumflex iliac vein, superficial external pudendal vein and Superficial epigastric veins drain at fossa ovalis directly and small, multiple veins like accessory saphenous and lateral superficial femoral vein draining into saphena magna far below fossa ovalis. – 37%

B. Multiple divisions of the medial and lateral femoral veins of small caliber - 6%

C. The large lateral superficial femoral vein drains into fossa ovalis. The constant thoraco epigastric vein drains into saphena magna. – 2%

D. The lateral superficial femoral and the accessory saphenous vein drains into fossa ovalis.

TYPE - II

A. The accessory saphenous vein forms a common stem with superficial external pudendal vein before joining Saphenous vein. – 6%

B. Common trunk formed by the lateral superficial femoral vein, superficial circumflex iliac and superficial epigastric veins drain into fossa ovalis- 9 %

C. A common trunk formed by the lateral superficial femoral and the superficial circumflex iliac veins drain into fossa ovalis. – 9%

D. The superficial epigastric and superficial external pudendal vein form a common trunk. A large lateral superficial femoral vein is present. – 2%.

TYPE - III

A. An accessory saphenous vein is present. Double superficial external pudendal veins present – 1%.

B. Double superficial external pudendal veins drain into fossa ovalis. – 3%.

C. The superficial epigastric vein drains into vena Saphena magna below the fossa ovalis. – 3%.

D. The superficial circumflex iliac vein drains into Femoral vein. – 1% .

TYPE- IV

A. All high collateral veins drain directly into Femoral vein – 6%.

B. The lateral femoral and the superficial circumflex iliac veins form a common trunk. The other high collateral veins drain directly into the Femoral vein. – 1%.

C. The lateral femoral vein drains into the fossa ovalis. The superficial epigastric vein drains directly into the Femoral vein-6%.

D. The medial and lateral superficial femoral veins are multiple and of smaller caliber. The superficial circumflex iliac and the superficial external pudendal vein drain directly into the Femoral vein- 1%.

TYPE - V

A. The lateral superficial femoral vein drains directly into the Femoral vein – 1%.

B. A double vena saphena magna with joining at fossa ovalis. – 3%

C. The saphena magna pierces the deep fascia to enter the femoral vein about 1 inch below the fossa ovalis. – 1%

In toto

Normal drainage pattern. – I A

Insignificant medial and lateral superficial femoral veins. – 44%

Double saphenous vein. – 3%

Direct drainage of higher tributaries into femoral veins either single or

Collectively. – 16 %

Daseler, E.H Anson,B.J, Reimann,A.F, And Beaton, L.E (1946) In their work on 550 specimens where they studied veins entering into Great saphenous vein close to its upper end they found the following data as shown in Table No 2.

Type I (A) Lateral accessory saphenous vein is constant tributary of larger size than other upper tributaries of the saphenous vein and some times larger than the Great saphenous vein - 15 %

Type II (B) The superficial epigastric vein and superficial circumflex vein formed a common trunk and drained into Great saphenous vein at fossa ovalis. The other tributaries drained directly into Great saphenous vein. – 15 %

Type III (C) The circumflex iliac vein and the lateral accessory saphenous vein drained into the Great saphenous vein by a common trunk. – 13 %

Type IV (D) The superficial external pudendal vein and the superficial epigastric vein formed a common trunk and drained in to Great saphenous vein.-6%.

Type V (E) The medial accessory saphenous vein occurred as an unusual tributary at fossa ovalis and it drained in common with external pudendal vein. – 8%.

Type VI (F) The lateral superficial accessory vein, superficial circumflex iliac vein and superficial epigastric vein drained in to the Great saphenous vein by a common trunk. – 33 %

Type VII (G) The lateral accessory saphenous vein and superficial epigastric vein drained into Great saphenous vein by a common trunk. – 2%

Type VIII (H) The lateral accessory saphenous vein and superficial circumflex iliac vein drain into Great saphenous vein by a common trunk. – 8%

Type (i) Transformation of Type I and Type VI

Arlie R. Mansberger, George H.Veager, Rennert M, Smelser, Frank M. Brumback, (1950) reviewed the result of some 650 dissections of Saphena magna at the fossa ovalis and grouped the anomalies into three categories.

Group I – One or more superior major tributaries empty into medial or lateral accessory saphenous – 13.1 %.

Group II – One or more tributaries empty into a medial or lateral femoral cutaneous vein – 9.8 %.

Group III – More than three superior tributaries may be found emptying into

Sapheno-femoral bulb – 16.4 %.

Combination of I and III – 6.5 %.

Combination of II and III – 3.3 %.

They also made a composite study with the one made by Daseler and Glasser and grouped it as

1. One or all of the superior tributaries may fuse before terminating in the Saphenous or Femoral veins.

2. One or all of the superior tributaries may empty directly into the Femoral vein.

3. One or all of the Superior tributaries may drain into a medial or lateral accessory Saphenous vein.

4. One or all of the Superior tributaries may join a medial or lateral femoral cutaneous vein.

5. Several rare anomalies which do not fall in this group are

    A) Lateral femoral cutaneous, Saphena magna and accessory saphenous may all be present and of approximately equal caliber.

B) The Saphena magna may pierce the deep fascia of the thigh to enter the femoral vein approximately 1 inch below the fossa ovalis

C) A lateral femoral cutaneous vein may drain directly into the Femoral vein above the fossa ovalis.

Buchanan (1953) quoted that the Long saphenous vein receives the superficial circumflex iliac, the superficial epigastric, and the superficial external pudendal veins. These three superficial veins often join together to form a common trunk.

R.D. Lockhart, G.F. Hamilton, F.W. Fyfe. (1959) say that the Femoral vein might sometimes receive some of the normal tributaries of Saphenous vein and in that case Femoral vein has been mistaken for the Saphenous vein and ligatured in error.

G.J. Romanes (1964) stated that as the Long saphenous vein traverses the cribriform fascia the vein receives the superficial circumflex iliac, the superficial epigastric, and the superficial external pudendal veins; These superficial veins often join together to form a common trunk.

Ernest Gardner, Donald J. Gray, Ronan 'O' Rahilly (1967) regarding the tributaries of the Great saphenous vein stated that in one third of instances the external pudendal vein entered separately, the superficial

circumflex iliac, superficial epigastric, and lateral accessory saphenous vein entered by a common trunk.

Chun Mh, Han Sh, Chung Jw, Et Al (1992) studied in 249 lower limbs of embalmed Korean cadavers the draining pattern of saphenous tributaries. The medial accessory vein drained into the Great saphenous vein directly in 82.3 % or by a common trunk in 17.7% with the superficial epigastric or superficial external pudendal vein.

The lateral accessory saphenous vein entered the Great saphenous vein in 67.1 % or the Femoral vein in 32.9% directly, or by a common trunk with other tributaries of saphenous vein. Superficial epigastric vein joined Great saphenous vein in 77.1 % or femoral vein in 22.9% directly or by a common trunk with other saphenous tributaries.

The superficial circumflex iliac vein reached the Great saphenous vein in 83.1 % or the Femoral vein in 16.9 % directly or by a common trunk with other saphenous tributaries.

The superficial external pudendal vein opened into the Great saphenous vein in 95.2 % or the Femoral vein 4.8 % directly or by a common trunk with other saphenous tributaries

The incidence of the normal pattern of saphenous tributaries was 23.7 % and in 76.3 % any one of the variant saphenous tributaries entered the Femoral or Great saphenous vein by a common trunk with other saphenous tributaries.

Janowski K, Topol M (2004) conducted 94 varicose vein operations by the Babcock method on patients and grouped 5 types of major saphenous vein tributary drainage. The most common type was

Type I, in which there were 3 tributaries draining directly into major Saphenous vein . This type had 45 cases (47.87 %) .In type II, 4 direct tributaries drained into Saphenous vein. This type had 23 cases. 24.46 %.In type III, 2 direct tributaries drained into Saphenous vein. It occurred in 14 cases (14.89 %).Type IV occurred in 8 cases (8.51 %). Here 5 or 6 tributaries depending on the number of external pudendal veins draining in to Saphenous vein. Type V turned out to be very rare, occurring in only 4 cases (4.25 %)

M. Donnely, S. Tierney And T.M. Feeley (2005) recorded the anatomy of the Sapheno- femoral junction in 2089 consecutive groin dissections. In more than half of the dissections 1200 of 2089 (57.4%) there were 3 or fewer tributaries to Long saphenous vein; 796 (38.1%) had four or five tributaries to Long saphenous vein ; 93(4.5%) had more than five tributaries ;In a small number of dissection 8 (0.4%) there were no tributaries to the Long saphenous vein, with only junctional tributaries identified.

Ab Ndiaye, M Diop Et Al (2005) In their dissection of 40 inguino femoral regions in fresh black African corpses, the convention type in a “vein star” shape was present in 4 cases. An abdominal common vein produced through the merging of the superficial epigastric and superficial circumflex iliac veins was found in 5 cases. A genital common vein summarizing the external pudendal veins in 19 case. In 8 cases, the abdominal and genital common vein was simultaneously present.

6. RELATIONSHIP OF GREAT SAPHENOUS VEIN WITH SAPHENOUS NERVE AND EXTERNAL PUDENDAL ARTERY.

Sir John Bruce, Robert Walmsley, James A Ross (1964) noted that the superficial external pudendal artery passes superficial to the termination of the great to of the great saphenous vein in about 30%

Jorgen Bendix Holme, Kirsten Holme And Lone Schmint Srensen (1988) dissected and demonstrated the relationship between the Long saphenous vein and the saphenous nerve in 60 cadaver legs to be as four types as shown in table No 3.

Type I (most common), the Saphenous vein and the Saphenous nerve met a few cm below the knee, after which the two were inseparable to the medial malleolus . It was noted in 41 legs (68%)

Type II began proximally as Type I, but the Saphenous vein and the Saphenous nerve separated a few cm above the malleolus. It was noted in 10 legs.(16 %)

Type III Saphenous vein and nerve are inseparable in the entire course down the leg. It was noted in 7 legs (11 %)

Type IV They were separate through out there course. It was noted in 2 legs (3%)

Murakami G, Negishi N, et al (1994) investigated the anatomical relationship between the Saphenous vein and cutaneous nerve in 148 lower limbs of 74 cadavers. The Great saphenous vein frequently ran intimately along the saphenous nerve (59.5%) in the middle third and 83.1% in the lower third of the leg.

More than half of the latter cases showed an adhesive relationship in which perineurium of the saphenous nerve was seen histologically to be attached to the adventitia of the vein.

M. Donnelly, S. Tierney and T.M. Feeley (2005) studied the anatomy of sapheno-femoral junction, tributaries and relationship of external pudendal artery to saphenous vein in their 2089 groin dissections and recorded that external pudendal artery was not visualised in 1527 (73.1%) of dissections where identified, it lay anterior to the Long saphenous vein in 350 dissections (16.8%) and above the sapheno-femoral junction in 24 (1.1 %). External

pudendal artery crossed behind a ascending tributary and anterior to the Long saphenous vein (or between two trunks of a bifid long saphenous system) in 96 dissections 4.6 %

7. PERFORATORS.

Charles Kosinski (1926) reported about the arrangement of anastomatic channels between superficial and deep veins were few in number but one or more occurred regularly at about the middle of the thigh.

The arrangement of anastomatic channels are by transverse vessels situated just below the knee joint, (2 – 3) in number connecting Great saphenous vein with medial articular and superior genicular veins.

At the junction of the middle and superior thirds of the leg, usually the anastomatic channels are two in number connecting Great saphenous vein both with medial gastrocnemial and posterior tibial veins.

At the junction of middle and distal third of the leg the anastomatic vessel is small connecting Great saphenous vein to the posterior tibial vein.

George. A .Piersol (1930) stated that the Great saphenous vein throughout its entire course makes numerous connections with deep veins, with the anterior tibial vein by some 5 or 6 branches, with the posterior tibial vein by usually 3 and with Femoral vein or one of its tributaries by usually a single one.

Sir John Bruce, Robert Walmsley, James A Ross (1964) stated that Great saphenous vein has some 5 or 6 perforating veins with anterior tibial and usually 3 with posterior tibial veins.

In the thigh there is a constant rather long perforating vein beginning at the Great saphenous vein or its tributary and about lower third of the thigh ends in Femoral vein in adductor canal. Below the knee, 1 perforating vein to posterior tibial vein is seen.In the lower half of the leg, the so called internal perforating veins are 3 in number. The upper is the most constant in situation at about the junction lower third and middle third of leg.

Ernest Gardener.M ,Donald J.Gray, Ronan 'O' Rahilly (1967) stated that direct perforating veins which pass directly from a superficial to a main deep vein are found one in the thigh and another in the leg; a series of important ones are found about the ankle. Indirect perforating veins connect superficial veins with muscular veins; they are small and numerous.

Platz F; Adelmann G (1976) mentioned among the perforating veins of the Great saphenous vein in the leg three are "most usual", been equally spaced between medial malleolus and the mid calf; more than 3 was termed the "most uncommon" and an arch vein perforator above mid calf "extremely rare".

Hamish Thomson (1979) described the perforators individually in 64 limb and observed

1. Hunterian perforator – A vessel which joined Great saphenous vein in the thigh to Femoral vein or its muscular tributaries in 24 limbs (48%).

2. Posterior tibial perforators – A vessel found a hand breadth or so below the knee from the Long saphenous vein in 46 limbs (92%).

3. Medial ankle perforators-There is an elongated triangle on the medial aspect of the lower half of leg called as " venous triangle". It is bounded by the subcutaneous border of the tibia, anterior border of the soleus and below by the flexor retinaculum. Perforators pierce the fascial roof of this triangle which communicates directly with the posterior tibial venae comitantes with posterior arch complex.

Gardener, Gray – Orahilly (1986) stress that the perforating veins which are clinically most important are in the calf, at the level of tibial tubercle and at the level of adductor canal which connect the superficial and deep veins.

8. NUMBER OF VALVES.

Henry Gray (1858) 39th edition stated that the vein has from 10 to 20 valves, which are more numerous in the leg than the thigh. One is present just before it pierces the cribriform fascia, another at its junction with the Femoral vein.

Klotz (1887) reported the number of valves in Great saphenous vein to be 6 to 25;

Kampmeir And Birch (1927) they found that the number of valves in the Great saphenous vein from 6 to 14 in 34 limbs. The valves are variably placed, but typically one is located in the upper part of the Great saphenous vein.

When a series of 100 veins were investigated by them, a valve was found at the mouth of the Great saphenous vein in 82, one varying from 1 to 13 cm, lower down in 16, and no valve at all present in the upper part in two.

George A. Piersol (1930) stated that Great saphenous vein possesses twelve to eighteen valves, in its entire course, some of which, especially in old individuals are apt to be insufficient.

Buchanan (1953) stated that Long saphenous vein may have as many as fifteen valves, but in most cases they are less numerous. One valve occurs in the vein just before it traverses cribriform fascia and another at its opening into the Femoral vein.

Morris (1953) stated that the Great saphenous vein usually contains from six to 18 valves. Occasionally few if any valves are present in the adult; and in advanced age, especially certain valves are insufficient.

C.D. Van Cleave And Russell L. Holman (1954) they reported a comparative study of valves and the finding in 43 case of varicose veins with those in the veins of 198 extremities of 102 normal individuals.

The 198 veins examined varied in length from 20.5cm to 50 cm; the average length was 39.65cm. the mean number of apparently competent valves found in these 198 veins was located at the sapheno-femoral junction in 89.5% of the veins examined. Examination of 2155cm of vein included in 43 routine surgical specimens marked “Varicose veins” disclosed 128 valves or an average distance between the valves of 16.8cm.Examination of 7852cm of veins in 198 extremities (102 cadavers) of normal individuals revealed 892 valves or an average distance between valves of 8.8cm.

J.C.B Grant (1957) according to him the Great saphenous vein has from eight to twenty bicuspid valves.

Russell T. Woodburne (1961) said that the valves in the Great saphenous vein vary from ten to twenty in number; They are more numerous in the leg than in the thigh.

Roger Warwick (1963) found numerous valves in the Long saphenous vein, especially below the knee. Two are situated at the upper end of the vessel, just below its junction with the Femoral vein.

Sir John Bruce, Robert Walmsley, James A Ross (1964) quoted that there are eight to ten valves in the Saphenous vein below the knee.

G.J Romanes(1964) according to him the Long saphenous vein is said to have about fifteen valves but in most cases they are most less numerous. One valve is found in the vein just before it traverses the cribriform fascia, and another at its opening into the Femoral vein.

Shinohara H, Morisawa S, Toshima M, Mizukami S (1990) state that in their study of the number and distribution of valves in 26 Great saphenous veins, the number of valves per vein range from 3 to 11 with an average of 6.7. The valves tended to be concentrated in the junction and the other between 35cm and 45cm of the sapheno-femoral junction. More than 55% of the valves located in these two segments.

Pang As (1991) stated that in his study of Great saphenous vein in 20 human cadaver legs valve was present in the sapheno- femoral junction in 17/20 (85%) of the legs. The Great saphenous vein above the knee had 4.2+_1.5 valves. In a length standardized Great saphenous vein which measured 100 units from the sapheno-femoral junction to the knee joint line the first, second, third, fourth and fifth valves were located at 7.5+_3.6,34.3+_18.5; 61.0+_20.9;79.3+_17.6 and 83.0+_15.9 units from the junction respectively.

BRUSKA.M (1995) state that distribution of venous in valves in great saphenous vein or six human fetuses and found the venous valves in the supergenicular portion of the great saphenous veins. The valves appear as delicate projections arranged perpendicular to the length of the vessel.

Czarniawska – Grzesinska M, Bruska M(2003) performed their study in Great saphenous veins in human foetuses of both sexes aged 9 to 37 weeks and observed the earliest well shaped valves in foetuses. The number of valve varies from 2 to 7.

HISTOLOGY.

E.A. Schaffer (1912) Stated that the veins have relatively thinner coats than arteries. The three coats which are distinguished in veins are named external, middle and internal coats.

Internal coat consists of endothelium, sub endothelial connective tissue layer and a not very well marked elastic layer. Endothelium of veins are shorter and broader.

Middle coat. In the veins of limbs the muscular fibers have the most part as in the arteries a transverse direction.

External coat. It is often thicker and consists of dense areolar tissue and longitudinal elastic fibers.

William Bloom and Don C. Fawcett. Stated there are longitudinal or circumferential smooth muscle fibers in the subendothelial connective tissue layer of tunica intima of the iliac, femoral, popliteal, saphenous veins.

EMBRYOLOGY

The earliest Limb veins are a superficial distal arch and a post axial trunk in each limb; at a later period digital veins are connected with the arch, and a pre-axial trunk is formed.

The distal arch in the lower limb and its tributaries remain in the adult as the dorsal venous arch of the foot and the digital veins.

The pre-axial vein of the lower limb becomes the Great saphenous vein which is continued proximally to the posterior cardinal portion of the left common iliac vein as the proximal part of the Femoral vein and the External iliac vein.

MATERIALS AND METHODS.

STUDY MATERIALS.

A) Cadaveric study.

i) Forty four adult specimens from 16 male and 7 female cadavers.

ii) Six fetal specimens comprising of 2 male and 1 female foetuses.

B) Radiological study.

i) Adult duplex ultrasound scanning.

ii) Colour Doppler scanning.

C) Histological study.

Specimen collection.

Adult specimens were obtained from 22 embalmed adult cadavers of age group 50 to 80 years from Institute of anatomy, Madras medical college. Fetal specimens were obtained from 3 dead unclaimed foetuses, all from 7 to 9 months gestational age, from the Institute of Obstetrics and Gynaecology, Madras medical college. Fetal embalming was done by injecting 200ml of embalming fluid through aorta.

The Great saphenous vein segments of length 5 – 10 cm were collected from patients who underwent surgery for grafting procedure and varicose vein in the Dept of vascular surgery, Madras medical college. The vein segment were soaked in normal saline and wrapped in gauze and preserved in 10% formalin solution.

The Great sapheonus vein was studied by duplex ultrasound scanning and colour Doppler scanning in 5 patients who under went the procedure in Barnard Institute of Radiology, Government general hospital, Chennai.

METHODS OF STUDY.

A. CADAVERIC STUDY.

1. Adult specimens.

DIRECT DISSECTION METHOD.

A horizontal incision was made from anterior superior iliac spine to pubic tubercle. A vertical incision was made from pubic tubercle to medial malleolus. The skin and superficial fascia were reflected before the vein has been uncovered. By a peculiar darkness or blueness showing through the fat, the veins were isolated and separated from the surrounding tissue to its entrance into Femoral vein at fossa ovalis and downward for about 3 – 5 cm.

The length of the Great saphenous vein in the thigh and leg were measured using a thread with sapheno-femoral junction, medial epicondyle , medial malleolus as reference points . With the help of the thread and scale,the length of Great saphenous vein was measured.

The level of termination of Great saphenous vein with respect to pubic tubercle, inguinal ligament and anterior superior iliac spine were noted using thread and scale.

The superficial external pudendal vein emptying into the Great saphenous vein from the medial aspect was noted. The superficial circumflex iliac vein, superficial epigastric vein and lateral superficial femoral vein were observed from the lateral aspect. The pattern of drainage of these peri- inguinal tributaries into the Great saphenous vein was noted.

The relationship of external pudendal artery to the Great saphenous vein was studied.

In the leg, the course of Great saphenous vein and the main trunk of the saphenous nerve were dissected out and their anatomic relationship was registered.

The vein was followed throughout its course, the perforators being traced through the deep fascia. The vein was traced little beyond the medial malleolus to observe the type of formation. The great saphenous vein diameter was measured using a vernier caliper.

The great saphenous vein was opened and the number of valves present in the Great saphenous vein in the thigh and leg was recorded separately

After clearing the fat and fascia pictures were taken.

2. Fetal specimens:

Dissection of great saphenous vein in fetal specimen was a tedious procedure due to very small tributaries in the foetus. Same procedure as done in

adult dissection was repeated but with utmost gentleness and care and as many tributaries were dissected and pictures were taken.

B. RADIOLOGICAL STUDY.

Duplex ultrasound scanning done in Barnard Institute of Radiology, Government General Hospital was observed for 5 patients who underwent the procedure for examination of superficial vein.

The patient was asked to stand upright and using the probe of the colour Doppler machine which was an high frequency probe (7.5 megahertz) the sapheno-femoral junction was identified. Then the Great saphenous vein was traced along the medial aspect till the medial malleolus.

The course of the vein, sites of tributaries double segment were marked. The luminal diameter of vein was recorded at several locations. Reflux at sapheno-femoral junction and varicosities if any were noted.

C. HISTOLOGICAL STUDY:-

Three bits of specimens (Bits of Great saphenous vein) were acquired from the department of vascular surgery, MMC Chennai during their surgery on vascular grafting and varicose veins.

Tissues were fixed in 10% formalin and processed in graded alcohol, embedded in paraffin wax, made into wax blocks, cut into thin sections, mounted on slide, stained and studied under light microscope.

Staining procedure for formalin fixed specimens.

Deparaffinisation (xylol)

↓

Hydration with graded alcohol

↓

Staining with haematoxylin

↓

Differentiation with 1% acid alcohol

↓

Bluing with tap water

↓

Staining with eosin

↓

Dehydration with absolute alcohol

↓

Clearing with xylol

↓

Mounting the slide.

OBSERVATION

A. DISSECTION METHOD:

The findings of dissection of forty four adult lower limb specimens and six foetal specimens are summarized as follows under the following headings:

1. Formation of Great Saphenous Vein.
2. Length of Great Saphenous Vein.
3. Diameter of Great Saphenous Vein.
4. Level of termination.
5. Drainage pattern at Sapheno-femoral junction
6. Relationship of Great Saphenous Vein with saphenous nerve and external pudendal artery.
7. Perforators.
8. Number of valves.

1. FORMATION OF GREAT SAPHENOUS VEIN.

The Great saphenous vein is formed by the union of medial end of dorsal venous arch and medial marginal vein draining the superficial part of the sole in 26 specimens (52 %). (Pic No. 1, 2).

The great saphenous vein begins as a continuation of the medial end of the dorsal venous arch in 18 specimens (36 %). (Pic No. 3)

The great saphenous vein is found by the union of medial end of dorsal venous arch and medial dorsal vein of the great toe in 6 specimens (12 %). (Pic No 4) (Chart No. 1)(Table No 4)

2. LENGTH OF THE GREAT SAPHENOUS VEIN.

The length of the Great saphenous vein in 44 adult lower limbs was measured and the following observations were made.

The length of the Great saphenous vein in the leg from medial epicondyle to medial malleolus ranged between 30.5 cm to 40 cm with an average of 34.68 cm. The average length in females is 32.82cm and in males is 35.53 cm. The average length of the great saphenous vein in the leg on the left side is 34.79 cm, on the right side is 34.5 cm. The difference between both the sides is very minimal. (Table No. 5)

The length of the Great saphenous vein in the thigh from sapheno-femoral junction to medial epicondyle ranged between 30.0cm to 41.0cm with an average of 34.29cm. The average length of Great saphenous vein in females is 32.48cm and in males is 35.14cm. The average length of Great saphenous vein in the thigh is slightly higher on the left side (34.55cm) than on the right side (34.05cm). (Table No. 6)

So, the total length of the Great saphenous vein ranged from 61.9 to 81cm, the average being 69.08cm.The average total length of Great saphenous vein in females is 65.3cm and in male is 70.84cm.The total length of Great saphenous vein is greater on the left side (69.44cm) than on the right (68.73).(Table No. 7)

The average length of Great saphenous vein in the leg (34.68cm) is greater than that of the thigh (34.29cm). The length of Great saphenous vein is more in males than females.

The average length of the Great saphenous vein in the leg in 6 foetal specimens was 7.08cm. The average length of Great saphenous vein in the thigh in 6 foetal specimens was 6.68cm. The average total length of the Great saphenous vein in foetal limbs is 13.76cm. The length of Great saphenous vein in leg is longer than in thigh.(Table No 8)

3. DIAMETER OF GREAT SAPHENOUS VEIN.

The diameter of the Great saphenous vein is measured in 50 lower limbs The diameter of the Great saphenous vein in the thigh ranged from 0.2 to 0.4cm.The average diameter was recorded to be as 0.29cm. The average diameter of Great saphenous vein in thigh in females is recorded as 0.317cm which was found to be greater than the diameter of Great saphenous vein in thigh in males (0.29cm).(Table No 9)

The diameter of the Great saphenous vein in the leg ranged from 0.3 to 0.5cm. The average diameter of Great saphenous vein in leg is 0.38. The average diameter of both males and females is same (0.38cm).(Table No 10)

So, the diameter of Great saphenous vein was found to be greater in the leg than in the thigh.(Pic No. 5)

The average diameter of Great saphenous vein in 6 foetal specimens was found to be 0.07cm in thigh and 0.05cm in leg.(Table No 11)

4. LEVEL OF TERMINATION.

The sapheno-femoral junction is found to be within 3 -5cm lateral to pubic tubercle in 40 cases (90 %) and it is found to be less than 3cms lateral to pubic tubercle in 2 specimens (4%). It is found to be more than 5cm lateral to pubic tubercle in 3 specimens (6%).(Table No 13)

The distance between anterior superior iliac spine and sapheno -femoral junction was observed to be from 8.5 cm to 11.1 cm and average length is 10.22 cm.

The sapheno-femoral junction is 1.8 cm to 5.1 cm from the midpoint of inguinal ligament.

The sapheno-femoral junction was observed to be on an average 10.22 cm from the anterior superior iliac spine, 3.84 cm from the pubic tubercle and 2.9cm from the inguinal ligament.

In the foetal specimens the sapheno-femoral junction was found to be, on an average of 2.78cm from anterior superior iliac spine, 0.96 cm from the pubic tubercle, and 0.68 cm from inguinal ligament.(Table No 12)

5. DRAINAGE PATTERN AT SAPHENO-FEMORAL JUNCTION.

1. Drainage pattern of lateral accessory saphenous vein.

A. At sapheno-femoral junction.

In the 50 specimens studied (44 adult + 6 foetus) the vein draining the antero lateral region of the thigh drains into the great saphenous vein in the fossa ovalis in 44 specimens (88%). This vein is called the Lateral accessory saphenous vein.

The most common type of drainage of lateral accessory saphenous vein is, it drains along with the superficial circumflex iliac vein and superficial epigastric vein in 18 specimens (36%) (Pic No. 7).

It drained directly into Great saphenous vein in 19 specimens (38%) (Pic No 6). Along with superficial circumflex iliac vein alone it drained in 6 cases (12%) (Pic No. 8). In only one case (2%) it drained along with thoraco-epigastric vein and the superficial circumflex iliac vein (Pic No. 9).

B. Below sapheno-femoral junction.

In 6 specimens the lateral accessory saphenous vein drained into the Great saphenous vein below the fossa ovalis.(Table No 14)

2. <u>Drainage pattern of medial accessory saphenous vein.</u>

The vein which drains the postero-medial region of the thigh is called as medial accessory saphenous vein. The medial accessory saphenous vein drained at fossa ovalis into Great saphenous vein in 6 specimens (12%). (Pic No 10)

Out of these, in 3 specimens the medial accessory saphenous vein drained directly into Great saphenous vein (6%) (Pic No 10)and in 3 specimens it joins with external pudendal vein and drains into Great saphenous vein (Pic No. 11).

In the rest of other 44 specimens the medial accessory saphenous vein drained directly into Great saphenous vein below the fossa ovalis (88%) (Pic No. 12)

3. <u>Drainage pattern of superficial epigastric vein.</u>

The superficial epigastric vein drained directly into the Great saphenous vein at fossa ovalis in 25 cases (50%) (Pic No. 13).

In 18 cases (36%) the vein drained into Great saphenous vein in common with circumflex iliac and lateral accessory saphenous veins (Pic No. 16). The superficial epigastric vein drained along with superficial external pudendal vein in 2 cases (4%). The superficial epigastric vein and superficial circumflex iliac vein drained commonly in 5 cases (10%) (Pic No. 14).(Table No 16)

4. Drainage pattern of superficial circumflex iliac vein.

The superficial circumflex iliac vein drained directly into Great saphenous vein in 20 cases (40%) (Pic No. 15). The circumflex iliac vein drained along with epigastric vein in 5 cases (10%) (Pic No. 14). The circumflex iliac vein and lateral accessory vein drained together in 6 cases (12%) (Pic No.16).

Along with superficial epigastric vein and lateral accessory saphenous vein, the circumflex iliac vein drains into great saphenous vein in 18 cases (36%) (Pic No. 7).

The circumflex iliac vein drained along with thoraco epigastric vein and lateral accessory saphenous vein in one case (2%) (Pic No. 17). (Table No 17)

5. Drainage pattern of external pudendal vein.

The external pudendal vein drained directly into Great saphenous vein at fossa ovalis in 90% of the cases (45 cases) (Pic No. 13). In 2 cases (4 %) it

unites with epigastric vein (Pic No. 18) and in 3 cases it drained along with medial accessory vein (6%) into the Great saphenous vein (Pic No. 11).(Table No 18)

6. RELATIONSHIP OF GREAT SAPHENOUS VEIN WITH SAPHENOUS NERVE AND EXTERNAL PUDENDAL ARTERY.

1. Relationship of external pudendal artery to Great saphenous vein.

The relationship of external pudendal artery to Great saphenous vein was recorded in 50 specimens. In 37 cases (74%) the external pudendal artery was not visualized in sapheno-femoral region.

In 8 cases (16%) the external pudendal artery was found to be posterior to the great saphenous vein (Pic No. 20). In 5 cases (10%) the external pudendal artery was anterior to the Great saphenous vein (Pic No. 21).(Table No 19)

2. Relationship of saphenous nerve to great saphenous vein.

The relationship of saphenous nerve to Great saphenous vein was studied in all 50 lower limbs from knee to medial malleolus.

In 34 specimens (68%), the Great saphenous vein and saphenous nerve came close together a few cms below the knee, after which the nerve and the vein were inseparable up to the medial malleolus (Pic No. 22).

In 6 specimens (12%), the Great saphenous vein and the saphenous nerve separated few cms above the medial malleolus (Pic No. 23).

In 9 specimens (18%), the Great saphenous vein and the saphenous nerve were inseparable throughout their course in the leg from the level of knee to medial malleolus (Pic No. 24).

In 1 specimen the Great saphenous vein and the saphenous nerve were separate throughout their course in the leg (2%) (Pic No. 25). (Table No 20)

7. PERFORATORS.

The number of veins connecting the superficial Great saphenous vein and the deep veins are noted.

The number of perforating veins in the thigh ranged from 1 to 2. But 1 was a constant. The average number of perforator in the thigh is taken as 1.1.

The number of perforating vein in the leg ranged between 1 and 4, the average being 2 perforators. No significant change in the number of perforator was observed between right and left side.(Table No 21) (Pic No. 26, 27, 28)

8. NUMBER OF VALVES:

The number of valves present in the Great saphenous vein are noted. The average number of valves measured in Great saphenous vein in thigh from

sapheno-femoral junction to medial epicondyle is 3.36. It was equal on both right and left sides.

The average number of valves in Great saphenous vein in leg from medial epicondyle to medial malleolus is 4.8. It is slightly higher on the right side (4.9) than the left side (4.7).

In all the 44 lower limb specimens the valve at sapheno-femoral junction was a constant. (Pic No. 30)

The total number valves in Great saphenous vein ranged from 6 to 12, average being 8.2.

The valves in the Great saphenous vein of foetus could not be visualized in the present study.(Table No. 22) (Pic No. 31)

RADIOLOGICAL STUDY.

Five patients ware examined under colour Doppler ultrasound scanning and the following observation were made. The sapheno-femoral junction was noted and reflux was not present in the patients. the veins were examined from the thigh to medial malleolus along the medial aspect. The caliber and the course and the structure of the Great saphenous vein was normal through out the course.(Pic No 34, 35, 36).

HISTOLOGY.

On mounting the slide, under light microscopy, the following observations were made.

Tunica interna lined with flattened endothelium was observed. The tunica media was thinner and consisted of relatively little smooth muscle and elastic fibers. Tunica externa was the thickest layer and elastic fibers were noted in it. (Pic No 37, 38, 39).

DISCUSSION

1. FORMATION OF THE GREAT SAPHENOUS VEIN.

Russel.T.Woodburne (1961), G.J.Romanes (1964) stated that the dorsal venous arch of the foot ends medially by uniting with medial dorsal digital vein of the big toe to form the Great saphenous vein.

In the present study (2007), the formation of Great saphenous vein by the union of medial end of dorsal venous arch with medial dorsal digital vein of great toe was recorded in 12% of specimens which correlated with the above author's notes.

Hollinshead (1961), Roger Warwick (1963) quoted that the Great saphenous vein originates from the medial side of the dorsum of foot.

In the present study, the Great saphenous vein begins as a continuation of medial end of the dorsal venous arch in 36 % which correlates with the findings of Hollinshead and Roger Warwick.

Henry Gray (1858) said that the Great saphenous vein starts inferiorly as a continuation of the medial marginal vein which is formed by veins from more superficial part of the sole. The dorsal venous arch connects with the medial margin vein on the medial side.

In the present study, the dorsal venous arch connecting with the medial marginal vein on the medial side was recorded in 52% which is similar to that stated by Henry Gray.

2. LENGTH OF THE GREAT SAPHENOUS VEIN.

The comparison of the length of the Great saphenous vein between the study of **N.J.Papadopoulos et al (1981)** and the present study (2007) (Table No. 23)

The range of length of Great saphenous vein in the leg in the present study is (30.5 cm - 40 cm) which is slightly higher than N.J. papadopoulos findings. The average length of Great saphenous vein in leg both in males and females correlated with the author's findings of 34.5 cm and 33.8 cms. In the present study there was a minimal difference in the length of the Great saphenous vein in leg between the right and left sides the average length on the right side being 34.5 cms and the average length in left side being 34.7 cms.

The length of Great saphenous vein in present study 34.29 cms showed an increased range than the above findings. The male average length of the Great saphenous vein in the thigh is 34.6 cms and female average length is 33.2 cms which correlated with the findings of N.J Papadopoulos. No significant difference was noted between the right and left side lengths of Great saphenous vein in thigh in the present study (2007)

The total length of Great saphenous vein was found to be slightly increased in present study than quoted by Papadopoulos.

The average length of the Great saphenous vein in the leg in foetal specimen was 7.08 cm and the average length of Great saphenous vein in thigh was 6.68 cm while the average total length came to 13.76 cm. The length of the Great saphenous vein in the leg is longer than thigh.

3. DIAMETER OF GREAT SAPHENOUS VEIN.

Charles kosinski (1926) stated that the caliber of the Great saphenous vein is often less at its termination than in the lower part of leg.

In present study (2007), the average diameter of the Great saphenous vein in the thigh is 0.29 cm and that of the leg is 0.38 cm. Thus the present study correlates with the above author's statement.

Howard R. Mahorner et al (1938) measured the diameter of Great saphenous vein to be from 0.5 cm – 2 cm.

In the present study, the diameter of Great saphenous vein ranged between 0.2 – 0.4 cm and that in leg ranged between 0.3 cm to 0.5 cm, and the average diameter of Great saphenous vein is .2 - .5 cm. The range of diameter of Great saphenous vein was less when compared to author's findings.

The average diameter of 6 foetal specimens was found to be 0.07 cm in the thigh and .05 cm in the leg. (Table No. 24)

4. LEVEL OF TERMINATION.

Distance of fossa ovalis from inguinal ligament.

Morris (1893) quoted that in the thigh, the Great saphenous vein runs on the medial side of the front of the thigh to about 3.7 cm below the inguinal ligament, where it dips through the fossa ovalis (saphenous opening) in the fascia lata, and ends in the Femoral vein.

Basmajian (1952), Mavor and Galloway (1967) mentioned a accurately defined point 3 to 4 cm below the middle of the inguinal ligament as the saphenous opening through which the saphenous vein drains in to Femoral vein.

Adb. Ndiaye et al (2005) in their dissection of 54 inguino femoral regions of fresh black African corpses, they found on average, the top of the arch of Great saphenous vein was projected 4.19 cm from the inguinal ligament.

Buchanan (1953), G. J.Romanes (1964) stated that at a point about 1 ½ inches below the inguinal ligament the saphenous vein traverses the cribriform fascia and ends by joining the Femoral vein.

In the present study, the sapheno-femoral junction is found to be 1.8 cm to 5.1 cm from the midpoint of inguinal ligament. On an average it was found to be 2.9 cm from the inguinal ligament which is almost similar to the above author's findings. (Table No. 25)

Distance of fossa ovalis from pubic tubercle.

Basmajian (1952), Mavor and Galloway (1967) mentioned the saphenous opening to be situated 1.7 cm lateral to pubic tubercle.

Henry Gray (1995) quoted that the center of the saphenous opening to be 2.5 cm – 3.5 cm infero lateral to pubic tubercle.

Abd. Ndiaye et al (2005) found the arch of the Great saphenous vein was 3.83 cm from pubic tubercle.

Royle et al (1981) performed flush ligations of Long saphenous vein in 167 patients and found the sapheno-femoral junction to be with in 3 to 5 cm lateral to pubic tubercle in 94% and less than 3 cm in 2% and greater than 5 cm in 4 %. (Chart No. 2)

In the present study, the distance between pubic tubercle and fossa ovalis was observed to be from 2.8 cm to 5.2 cm through which the Great saphenous vein drains into the femoral vein.

The average distance is 3.84 cm which coincides with the findings of Gray and Abd. Ndiaye et al. Findings in present studies differs from that of Basmajian, Mavor and Galloway which is much lesser. The incidence of situation of sapheno-femoral junction 3 to 5 cm from pubic tubercle in present study (90%) is almost close to the incidence mentioned by Royle et al. (Table No. 26, 27)

Distance from Anterior superior iliac spine.

Abd. Ndiaye et al (2005) found the arch of the Great saphenous vein to be 10.88cm from anterior superior iliac spine.

In the present study, the distance between fossa ovalis and anterior superior iliac spine ranged between 8.9 cm – 11.1 cm. The average distance was found to be 10.22 cm which coincides with above author's findings.

In the foetal specimens, the sapheno-femoral junction was found to be on an average of 2.78 cm from anterior superior iliac spine, 0.96 cm from pubic tubercle, and 0.68 cm from midpoint of inguinal ligament which was not mentioned by any of the authors.

5. DRAINAGE PATTERN AT SAPHENO-FEMORAL JUNCTION.

Glasser (1943) classified the drainage pattern of veins at fossa ovalis based on five tributaries the superficial epigastric vein, superficial external

pudendal vein, superficial circumflex iliac vein, medial accessory saphenous vein and lateral superficial femoral veins. (Table No. 28)(Chart No. 3)

In the present study,

The most common pattern was found to be Type II (B) which was recorded to be as 36% very much higher than the study of Glasser 9%.

Type I (A) was found to be 30% which is less than study of Glasser.

Type I (C) was found to be 2% which was found to be similar to the study of Glasser.

Type I (D) was found to be higher than the study of Glasser accounting to (6%).

Type II (A) pattern is similar to the study of Glasser (6%)

Type II (C) and Type II (D) patterns were slightly higher than Glasser's study which was about 12% and 4% respectively.

Type V (B) pattern was near equal to that of Glasser's study (4%).

The patterns I (B), III (A), III (B), III (C), III (D), IV(A), IV(B), IV(C), IV(D), V(A) and V(C) were not observed in any of the specimens in the present which did not correlate with the study of the above author.

The most common pattern in the present study is II(B) (Common trunk formed by lateral superficial femoral and superficial circumflex iliac vein and superficial epigastric vein drain at fossa ovalis) 36% which was not the common pattern in author's study (9%)

Daseler (1946) studied the drainage pattern of sapheno-femoral junction based on five peri-inguinal tributaries. (Table No. 29) (Chart No. 4)

In the present study,

Type I (A) was higher than the author's study (30%).

Type II (B) was found to be low than that of the study of Daseler (10%).

Type III (C) correlated with the incidence of author's study (12%).

Type IV (D), Type V(E), patterns ware slightly lower than the study of Daseler (4%, 6% respectively.).

Type VI (F) was slightly higher than author's study (36%).

Type VII (G), Type VIII (H) – were not found in present study.

The present study included another 2% pattern of drainage in which thoraco epigastric vein drained. This pattern was not included in author's study.

Chun et al (1992) studied about each tributary at sapheno femoral junction opening either directly or in common with other tributary. (Table No 30)

The drainage of accessory medial saphenous vein directly was higher in the present study (94%) than the study of Chun et al. Lateral accessory saphenous vein drained directly and in common with other tributary equally (50%). This did not correlate with author's study.

The drainage of superficial circumflex iliac vein was higher in the pattern of common drainage. This also did not correlate with the author's study.

Superior epigastric vein drained directly and in common with other tributary equally. But in author's study the pattern of drainage of superior epigastric vein draining directly was higher.

Drainage of superficial external pudendal vein was almost similar to that of Chun et al study.

Ernest Gardener et al (1967)

Stated that external pudendal vein entered separately into the Great saphenous vein in 1/3 of the instances.

In the present study, the superficial external pudendal vein drained separately into the Great saphenous vein in 36%. This coincides with the study of Ernest Gardener et al.

6. RELATIONSHIP OF GREAT SAPHENOUS VEIN WITH EXTERNAL PUDENDAL ARTERY AND SAPHENOUS NERVE.

Sir John Bruce et al (1964) recorded that the superficial external pudendal artery passes superficial to the termination of the Great saphenous vein in about 30%.

M.Donnelly et al (2004) stated that external pudendal artery was not visualized in 73.1% of dissections, where identified it lay anterior to the long saphenous vein in 16.8% and above sapheno-femoral junction in 1.1%. External pudendal artery crossed behind a ascending tributary in 4.6%.

In the present study, the external pudendal artery passes anterior to the termination of Great saphenous vein in only 10% which was much lesser than Sir John Bruce et al study.

The external pudendal artery was not visualized in 74% which is similar to the finding of M.Donnelly (73.1%). In none of the cases the external pudendal artery was found to be anterior to the sapheno-femoral junction. The external pudendal artery was fond to be posterior in 16% which differs from

the study of Donnelly who stated the incidence to be 4.6%.(Table No. 31) (Chart No. 5)

Jorgen Bendix Holme et al(1988) demonstrated the relationship between long saphenous vein and saphenous nerve as four types from knee to medial malleolus. (Table No. 32)

The most common type in the present study is Type I pattern which is similar to Jorgen's study. The order of frequency in Holme's study Type I > Type II > Type II > Type IV where as in present study it was Type I > Type III > Type II > Type IV as shone in Table no :

7. PERFORATORS

Charles Kosinski (1926), John Bruce et al (1964), Ernest Gardener et al (1967), reported that the perforators were few in number but one or more occurred regularly about the middle of the thigh ending in the femoral vein in adductor canal. According to them, below the knee, one perforating vein to the posterior tibial vein and in the lower half of the leg , so called external perforating veins are three in number.

George A.Piersol (1930) stated that the Great saphenous vein throughout its course makes connection with the deep veins – with anterior tibial veins by five or six branches, with the posterior tibial vein by usually three and with femoral vein by one perforator.

Sherman (1944) found that number of perforators of the thigh in Great saphenous vein is ranged from 1 to 6 with an average of 1.94 in 101 dissections. The number of perforators of leg were a constant six.

In the present study, number of perforating veins in the thigh connecting to femoral vein ranged from 1 to 2 but 1 was a constant. The number of perforating veins in the leg ranged from 1 to 4 connecting the anterior tibial and posterior tibial veins.

These findings coincide with the findings of Kosinski, John Bruce and Gardener et al. Piersol's study shows a higher level of number of perforators in the leg (8) where as in the present study it is 2 to 4.

In the present study, the average number of perforator's in the thigh is 1.14 which almost coincides with the Sherman's statement.(Table No. 33)

8. NUMBER OF VALVES.

Klotz (1887) reported the number of valves in Great saphenous vein to be from 6 to 25.

Kampmeir and Birch (1927), George A. Piersol (1930), Buchannan (1953), Morris (1953), G.J.Romanes (1964) stated regarding the number of valves in Great saphenous vein to be from 6 to 18.

Russel T. Woodburne (1961), Henry Gray(1858) quoted the number of valves in Great saphenous vein to be 10 to 20.

In the present study, the total number of valves in Great saphenous vein ranged from 6 to 12 the average being 8.2 which co-related with the range given by Kampmeir and Birch, George A. Piersol, Buchannan, Morris, G.J.Romanes. The range given by Klotz was slightly higher than the present study.

C. D. Van Cleave and Russell. L. Holman (1954) reported in their study that a competent valve was located at the sapheno-femoral junction in 89.5% of the veins.

In the present study, a valve at the sapheno-femoral junction was located in all the cases (100%) which were slightly higher than the study of Van Cleave and Russell. (Table No. 34)

HISTOLOGY.

E. A. Schaffer (1912) stated that veins were relatively thinner than arteries. In the tunica intima endothelium and subendothelial connective tissue layer was noted. In tunica media the muscular fibers have the most part in transverse direction. The tunica externa is the thickest coat.

In the present study, the tunica intima showed the endothelium to be flat and subendothelial connective tissue layer was not seen. Tunica media displayed the muscular fibers were circumferential. Tunica externa was very thick than all the layers and displayed more elastic fibers. These all findings correlated with the study of Schaffer.

William Bloom and Don C. Fawcett. stated the presence of longitudinal fibers in the tunica media of great saphenous vein.

In the present study longitudinal fibers were not noted in tunica media.

CONCLUSION

Great saphenous vein, the vessel of surgical significance, has been studied in detail by dissection and radiological methods. The formation, length and diameter of Great saphenous vein, its level of termination, drainage pattern, its relation with adjacent important structures in detail have been observed and co-related with the findings of already existing studies. The following conclusions are derived from these parameters.

- In most of the cases the formation of Great saphenous vein was by the union of medial end of dorsal venous arch with medial marginal vein.
- The mean total length of the Great saphenous vein is 69.08 cm.
- The average diameter of Great saphenous vein in thigh is 0.29 cm and that in the leg is 0.38 cm.
- The sapheno-femoral junction on an average was 2.9 cm from the midpoint of inguinal ligament.
- In most cases, the sapheno-femoral junction was located 3 to 5 cm from pubic tubercle.
- The average distance from anterior superior iliac spine to sapheno-femoral junction is 10.22 cm.

- High proportion of cases display the drainage pattern with superficial circumflex iliac vein, superficial epigastric vein and lateral accessory saphenous vein forming a common trunk and terminating at fossa ovalis.

- In 1/3 of instances, the superficial external pudendal vein drains directly into Great saphenous vein.

- External pudendal artery passed anterior to termination of Great saphenous vein in significant proportion of cases.

- Most commonly the Great saphenous vein and the saphenous nerve came close few cm below the knee, after which they were in separable.

- Average no of perforating veins in the thigh is 1.14.

- Average no of valves in the Great saphenous vein is 8.2.

- In 6 foetal specimens, the sapheno femoral junction is found to be on an average 2.78 cm from the anterior superior iliac spine, 0.96 cm from pubic tubercle, 0.68 cm from mid point of inguinal ligament

Based on this study, I hereby conclude that Great saphenous vein has complex variations in length, drainage pattern and its relationship with external pudendal artery and saphenous nerve.

Surgery for varicose veins and saphenous vein grafting require a thorough knowledge of variations in Great saphenous vein. Hence this study will be of use to surgeons.

1. Abd Ndiaye, J Ndoye, O Diarra, M Diop, A Dia, M Ndiaye, M Sow: The arch of Great saphenous vein. Anatomical bases for failures and recurrence of varices in the pelvic limb. Surgical Radiological anatomy 2005; Oct 15; 1 – 7

2. Abd Ndiaye, M Diop, J Ndoye, A Dia, G Ciss, M Ndiaye, M Sow: About the tributaries of the arch of Great saphenous vein. Dakar Med. 2005; 50(2):41 – 45

3. Anthony D. Whittemore. Advances in vascular surgery. Vol 10. 2002

4. Arlie R. Mansberger, H.Yeager, Rennert M., Smeleser, Frank M. Brumback. Sapheno-femoral junction anomalies. Surgery gynecology and obstetrics. 1950 Nov; 91(5): 533 – 536.

5. Bruska M. Distribution of valves in the Great saphenous vein in Human fetuses. Folia Morphol. 1995;54(4):279 – 82.

6. Buchanans Manual of Anatomy. 1953; 8th edition.

7. C.D Van Cleave, Russell L.Holman. A Preliminary study of the number and distribution of valves in normal and varicose veins. The American surgeon. 1954; 20(1): 533 – 537.

8. Caggiati A, Mendoza E. Segmental hypoplasia of the great saphenous vein and varicose disease. Eur J Vasc Endovasc Surg. 2004; 28:257 – 261.

9. Caggiati A, Ricci S. The caliber of human long saphenous vein and its congenital variations. Ann Anat. 2000 Mar; 182(2):195 – 201.

10. Charles Kosinski. Observations on the superficial venous system of the lower extremity. Journal of anatomy. 1926; 60:131 – 142.

11. Chun MH, Han SH, Chung JW, Cho SS, Ko JS, Chung IH, Chung GB, Lee MS, Kang HS, Park SS. Anatomical observation on draining pattern of saphenous tributaries in Korean adults. J Korean Med Sci. 1992 Mar; 7(1): 25 – 33.

12. Czarniawska-Grzesinsk M, Bruska M. The structure of the valves in the Great saphenous vein in Human fetuses. Folia Morphol.2003; 62(3):275 – 276.

13. Daseler, E.H., Anson, B.J., Reimann, A.F., The saphenous venous tributaries and related structures in relation to techinique of high ligation. Surg, Gynec. and obst. 1946; 82: 53,

14. Edward Albert Schafer, Text Book of Microscopic Anatomy: 1912, 11th Edition

15. Ernest Gardener, Donald J.Gray, Ronan O' Rahilly. Anatomy: 1967, 2nd Edition.

16. G.J. Romanes. Text Book of Anatomy: 1964, 10th Edition.

17. George. A. Piersol, Human Anatomy: 1930, 9th Edition.

18. Hamish Thomson. The surgical anatomy of the superficial and perforating vein of the lower limb. Annals of the royal college of surgeons of England. 1979; 61: 198 – 205.

19. Henry Gray Text Book of Anatomy: 1858, 39th Edition.

20. Henry Hollinshead: Anatomy for Surgeons: 1961, 2nd Edition.

21. Howard R. Mahorner, Alton Ochsner. The morden treatment of varicose vein as indicated by the comparative tourniquet test. Annals of surgery. 1938; 107:927 – 951.

22. J. C. B. Grant, Anatomy of Respiratory, Blood Vascular System: 1957, 9th Edition

23. J.P. Royle, R. Eisner. The sapheno-femoral junction. Surg Gynecology and obstetrics. 1981;152 282 – 284.

24. Janowski K, Topol M. Types of outlet of the major saphenous vein tributaries in patients with chronic vein insufficiency of the lower limbs. Folia Morphol. 2004 Nov; 63(4):473 – 479.

25. Jorgen Bendix Holme, Kirsten Holme and Lone Schmidt Sorensen. Anatomic relationship between the long saphenous vein and the saphenous nerve. Acta chirurgica scandinvica. 1988; 154(1): 651 – 653.

26. Kampmeir, O. F., and Birch C. La F. the origin and development of venous valves with reference to saphenous district. Am. J. Anat. 1927; 38: 451,

27. Keith. L. Moore. Text Book of Anatomy: 1980

28. Klotz, K. Untersuchungen iiberdie vena saphena magna beim menschen. Arch. F. Anat. U. Physiol. 1887, P. 159.

29. L.T. Cotton. Varicose veins. Gross Anatomy and development. The British journal of surgery. 1960; 207 – 589 – 600.

30. M. Donnelly, s. Tierney and T.M. Feeley. Anatomical variation at the sapheno-femoral junction. British journal of surgery. 2005 Mar; 92(3): 322 – 325.

31. M. Prives, N. Lysenkov, V.Bushkovich, Anatomy : 1985

32. Milroy CM, Scott DJA. Histological appearance of the long saphenous vein. J Pathol. 1989; 159: 311 – 316.

33. Morris. Human Anatomy: 1953, 11th Edition.

34. Murakami G, Negishi N, Tanaka K, Hoshi H, Sezai Y. Anatomic relationship with between saphenous vein and cutaneous nerves. Okajimas Folia Anat Jpn. 1994 May; 71(1):21 – 33

35. N J Papadopoulos, M F Sherif and E N Albert. A fascial canal of Great saphenous vein. J Anat. 1981May; 132(3): 321 – 329.

36. Pang AS. Location of valves and competence of Great saphenous vein above the knee. Ann Acad Med Singapore. 1991 Mar; 20(2):248 – 50.

37. Platz F.Adelmann G Zur Anatomie der 'Vena arcuata cruris posterior' Anat ges Jena 1976 ; 70:709-714.

38. R.D. Lockhart, G.F. Hamilton, FW. Fyfe, Anatomy of Human Body: 1959

39. Roger Warwick, Synopsis of Regional Anatomy: 1963

40. Ronan o' Rahilly, Anatomy: 1986, 5th Edition.

41. Russel .T. Woodburne, Essentials of Human Anatomy: 1961, 2nd Edition.

42. S.T. Glasser; An anatomic study of venous variations at the fossa ovalis; Archives of surgery. 1943; 46:289 – 295.

43. Sherman RS. Varicose veins: anatomic findings and an operative procedure based upon them. Ann Surgery 1944; 120:772 – 784.

44. Shinohara H, Morisawa S, Toshima M, Mizukami S. Distribution of valves in the Great saphenous vein. Okajimas Folia Anat Jpn. 1990 Oct; 67(4):219 – 21.

45. Sir John Bruce, Robert Walmsley, James A Ross, Manual of Surgical Anatomy: 1964

46. William Bloom, Don W. Fawcett, Text Book of Histology: 9th Edition.

P

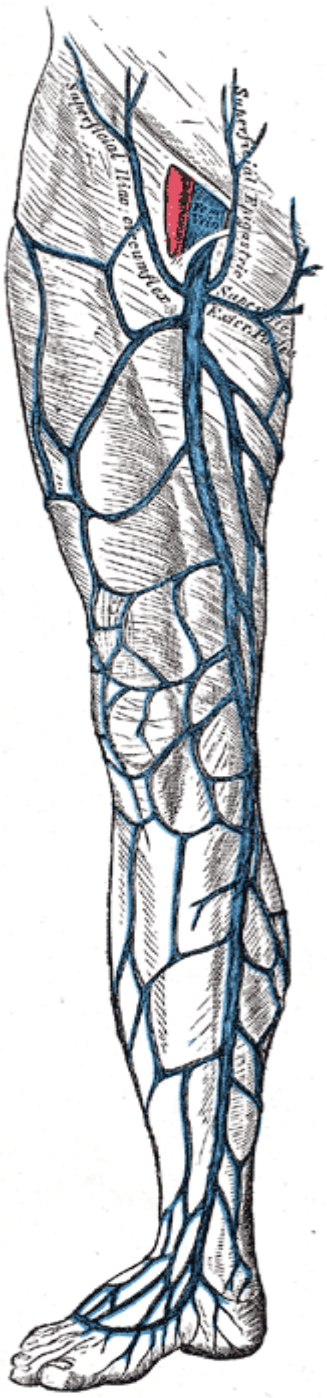
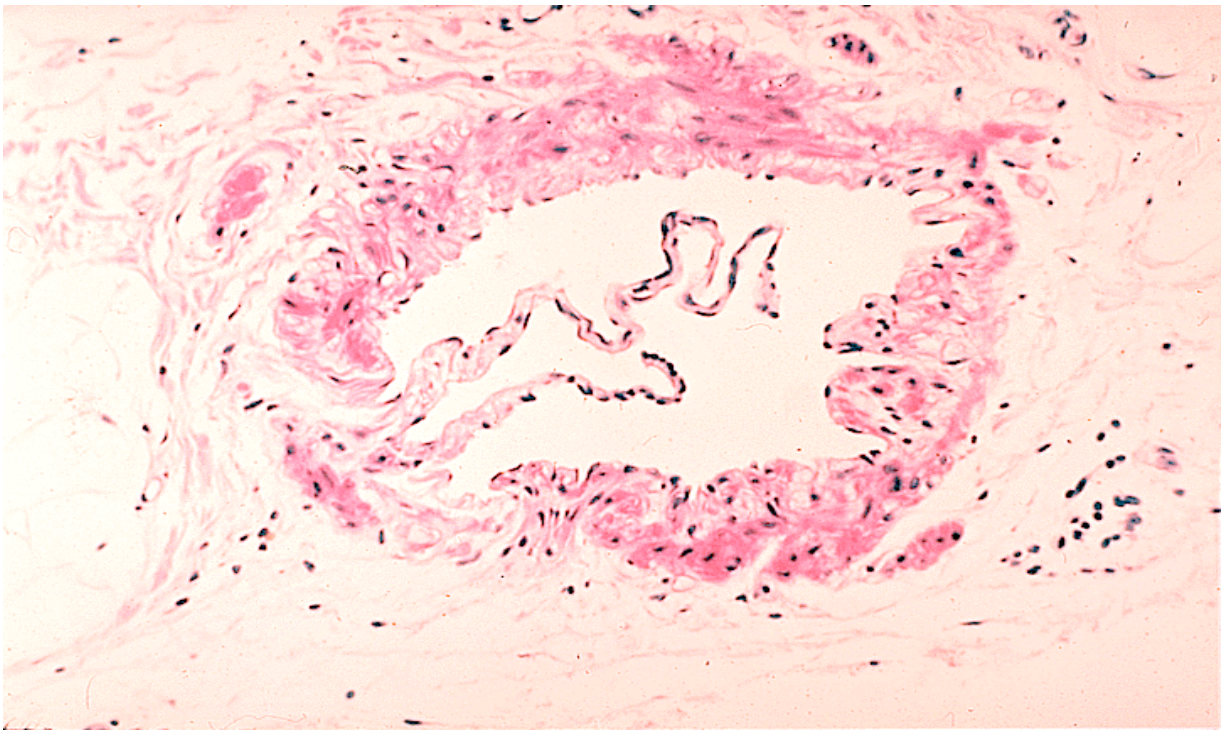
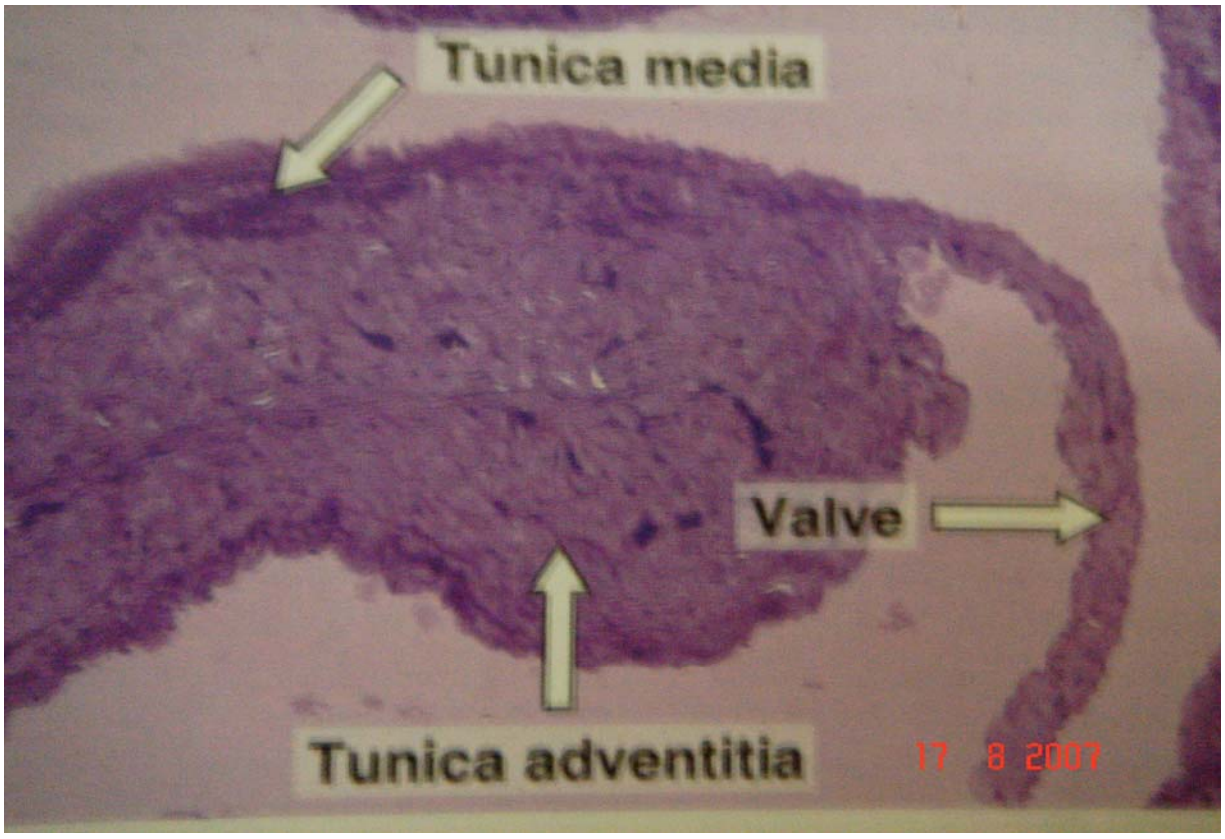
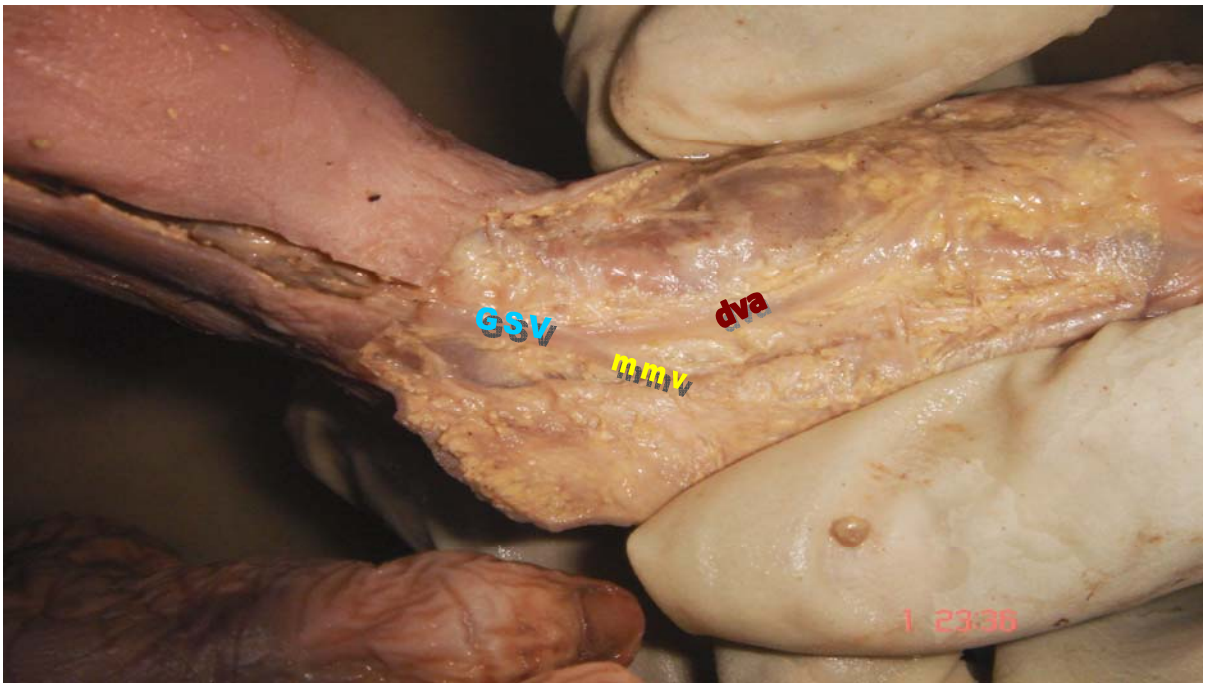


Fig 1: Course of Great saphenous vein

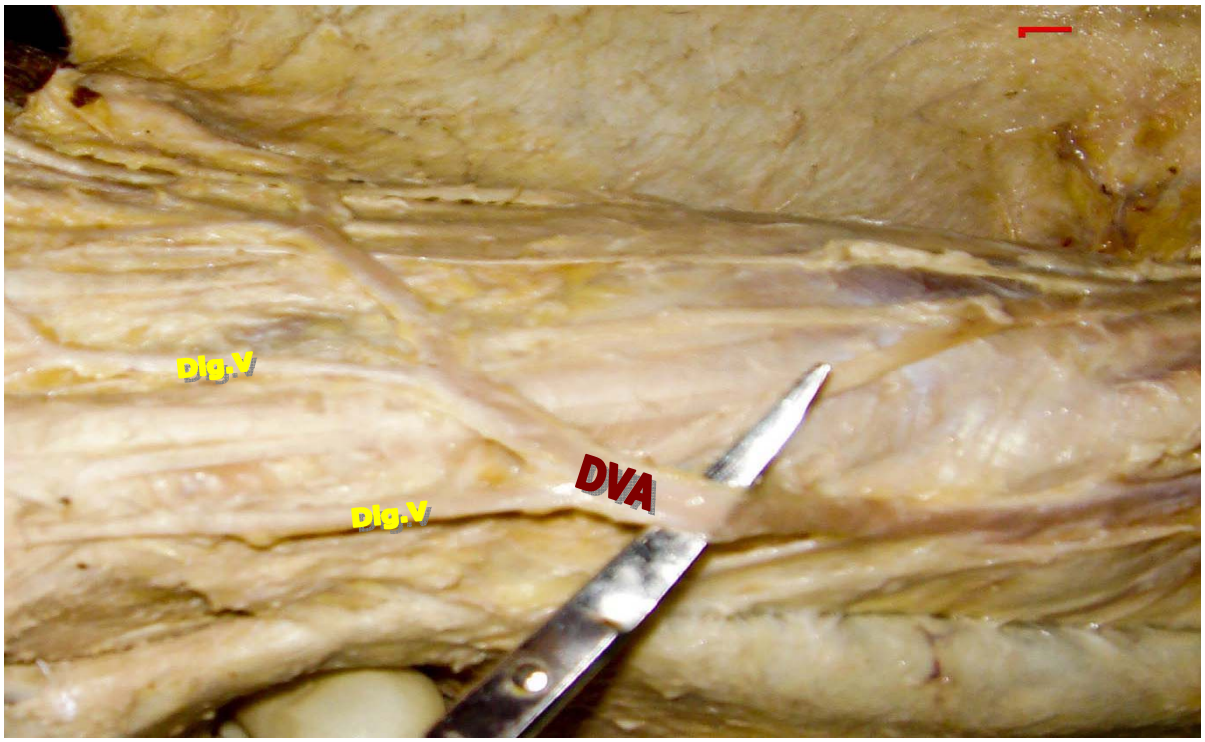
Fig 8 : Histology of Great saphenous vein.



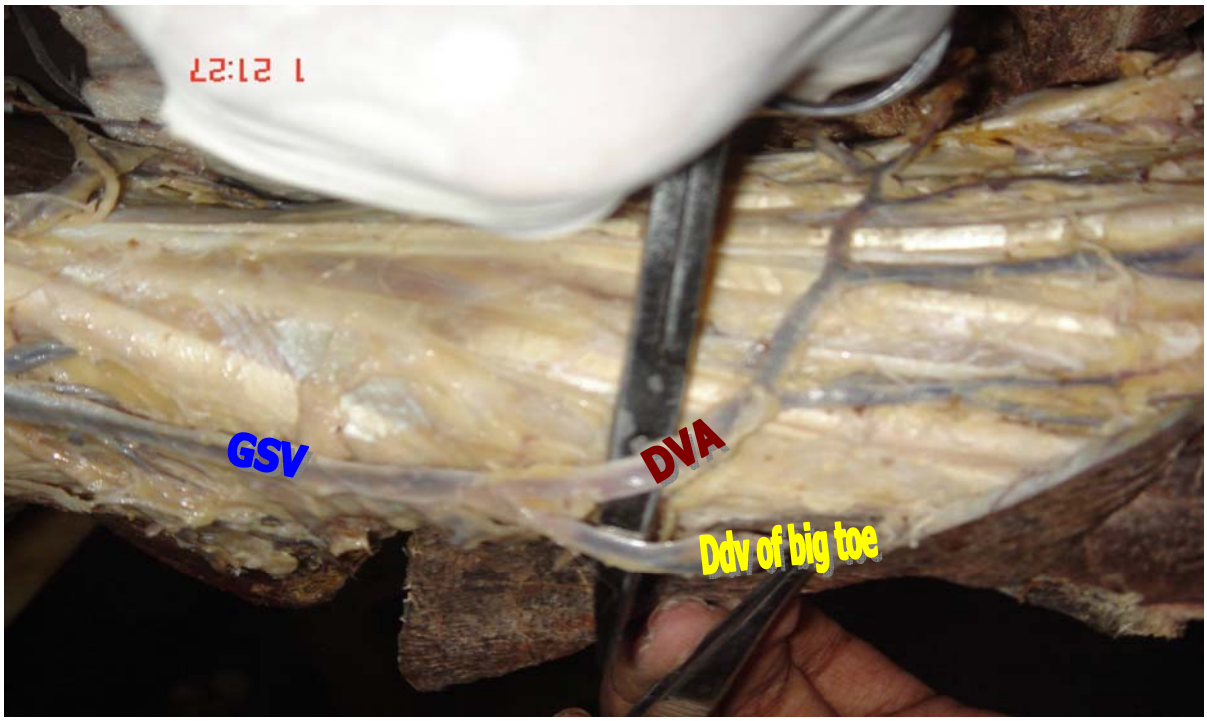




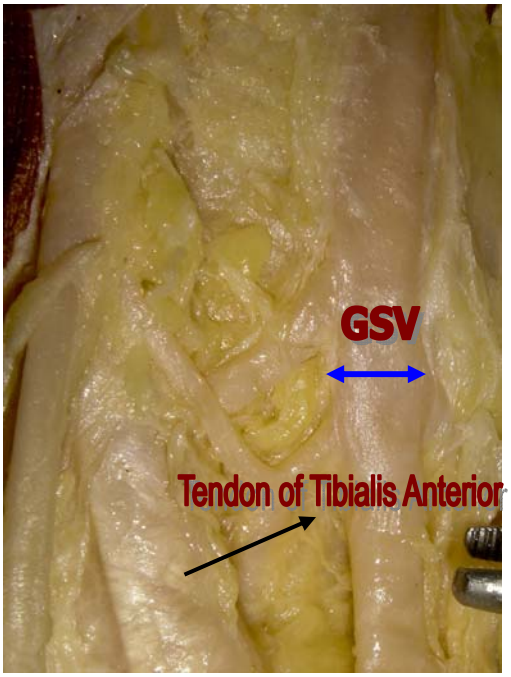
Picture 2: Formation of Great saphenous vein by Medial end of Dorsal venous arch and Medial marginal vein. (Right Side)



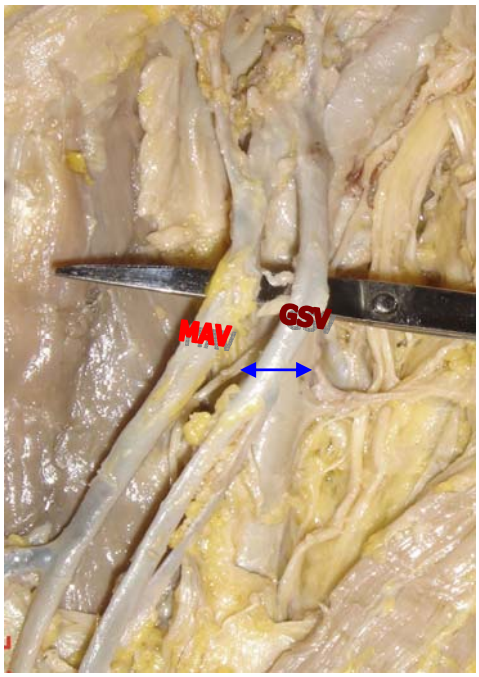
Picture 3: Formation of Great saphenous vein by Medial end of Dorsal venous arch alone. (Right Side)



Picture 4: Formation of Great saphenous vein by Medial end of Dorsal venous arch and medial dorsal vein of big toe. (Right Side)

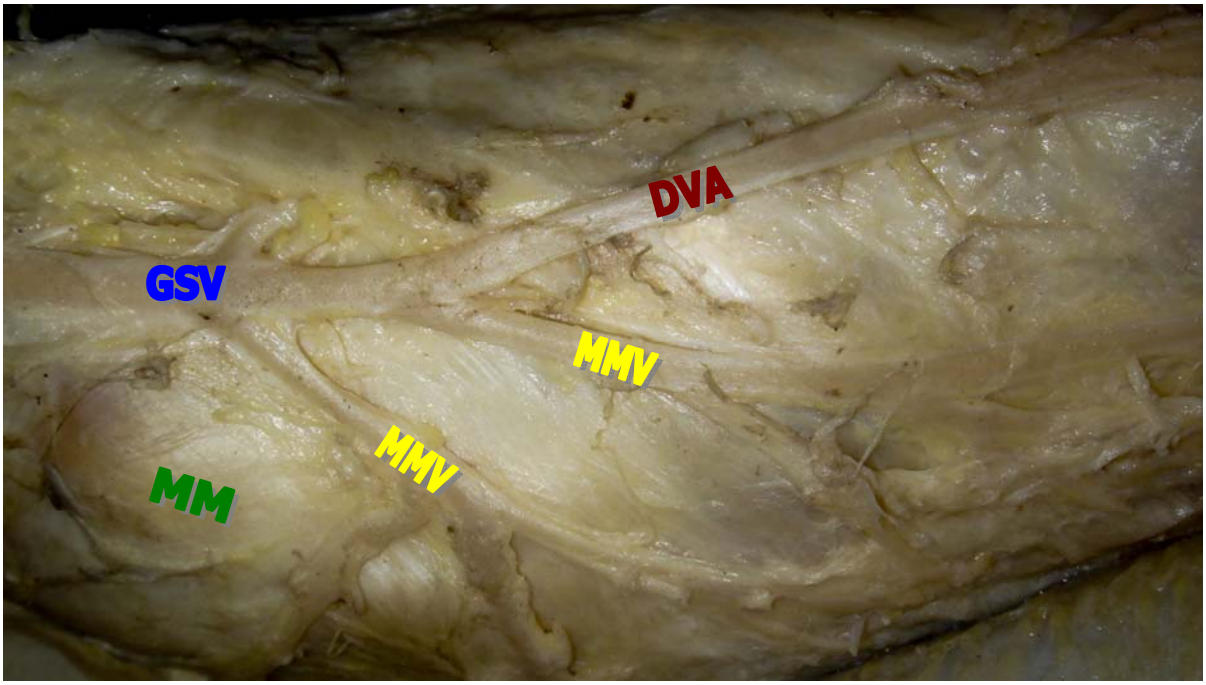


Right Side - Leg

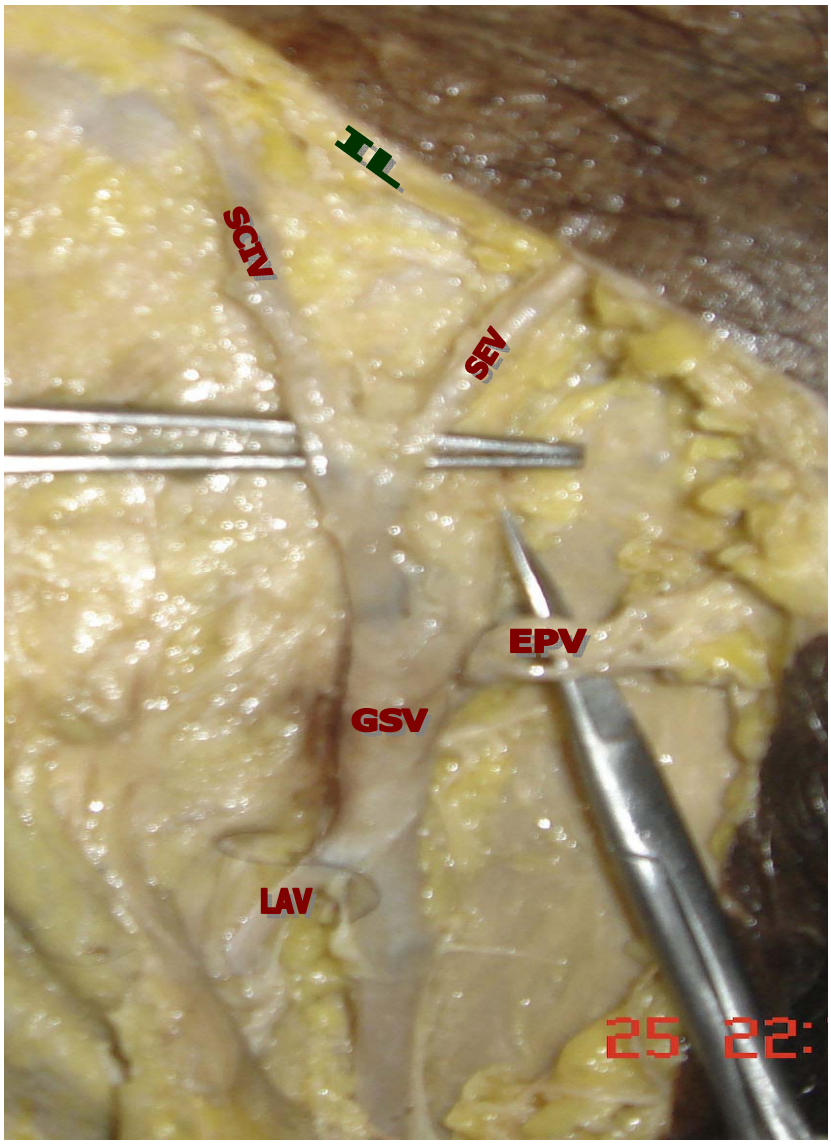


Left Side - Thigh

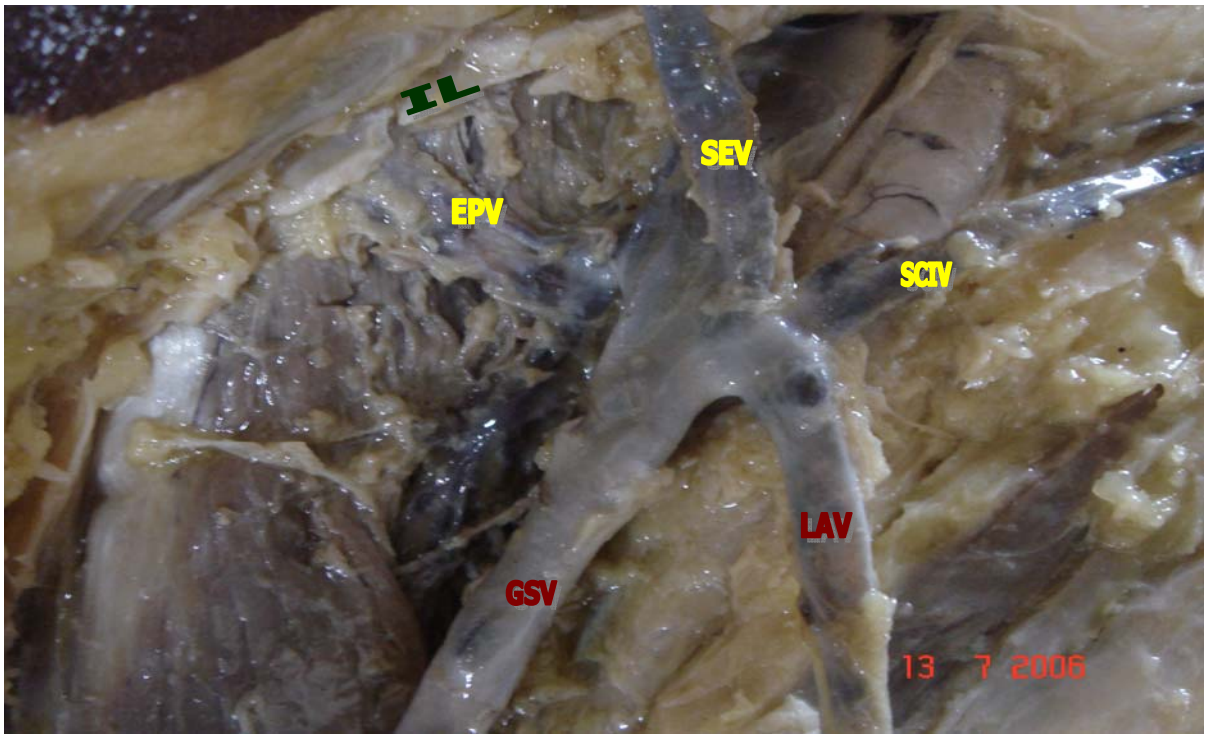
Picture 5: Diameter of Great saphenous vein in the Leg is greater than in the thigh.



Picture 1: Formation of Great saphenous vein by Medial end of Dorsal venous arch and Medial marginal vein.

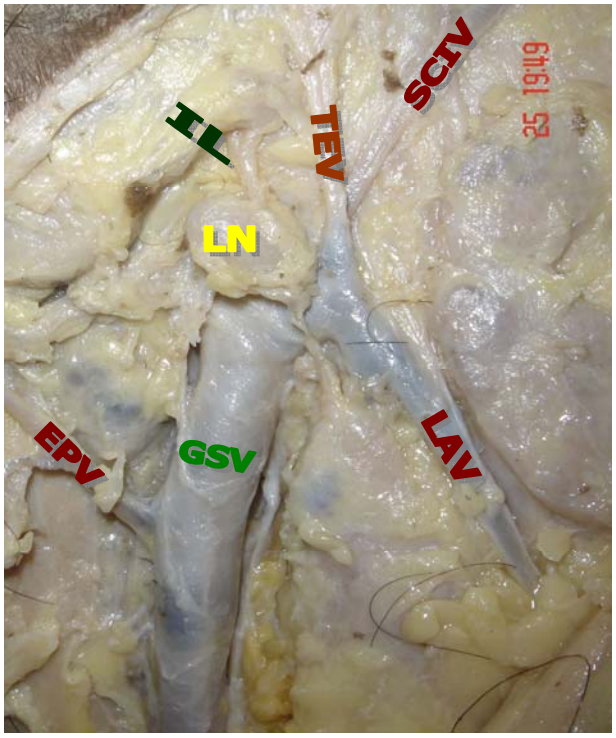


Picture 6: Lateral accessory saphenous vein draining directly into Great saphenous vein. (Right Side Thigh)

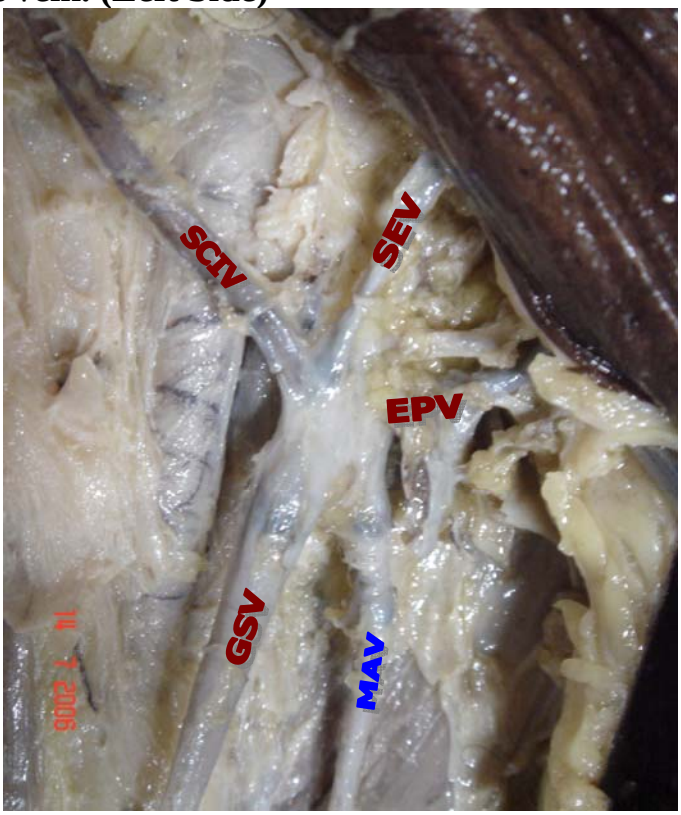


Picture 7: Lateral accessory saphenous vein draining in common with superficial circumflex iliac vein and superficial epigastric vein. (Left Side)

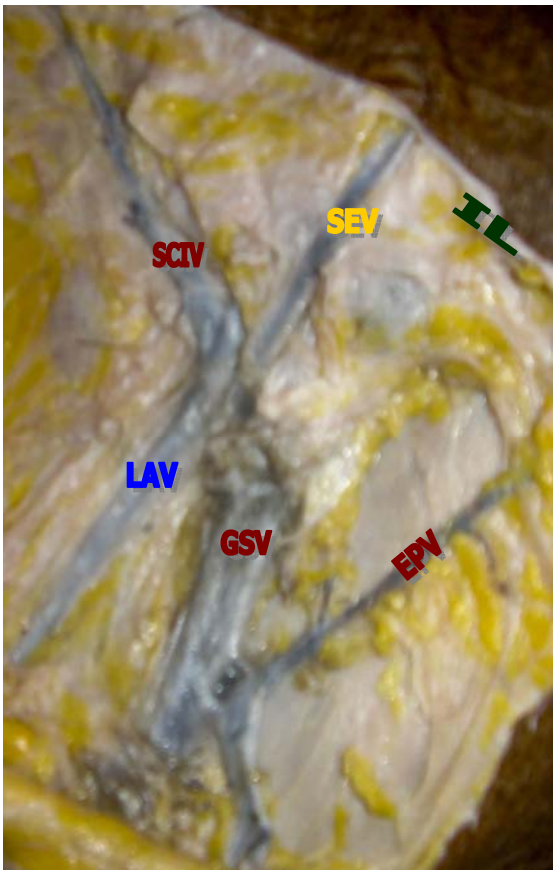
Picture 8: Lateral accessory saphenous vein draining in common with superficial circumflex iliac vein. (Right Side)



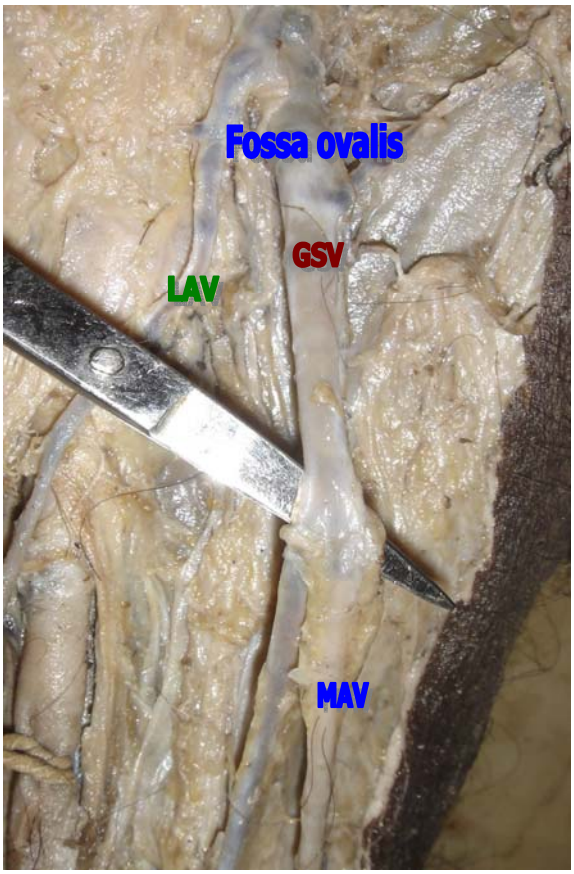
Picture 9: Lateral accessory saphenous vein draining in common with thoraco-epigastric vein. (Left Side)



Picture 10: Medial accessory saphenous vein drained directly into Great saphenous vein at fossa ovalis. (Right Side – Thigh)



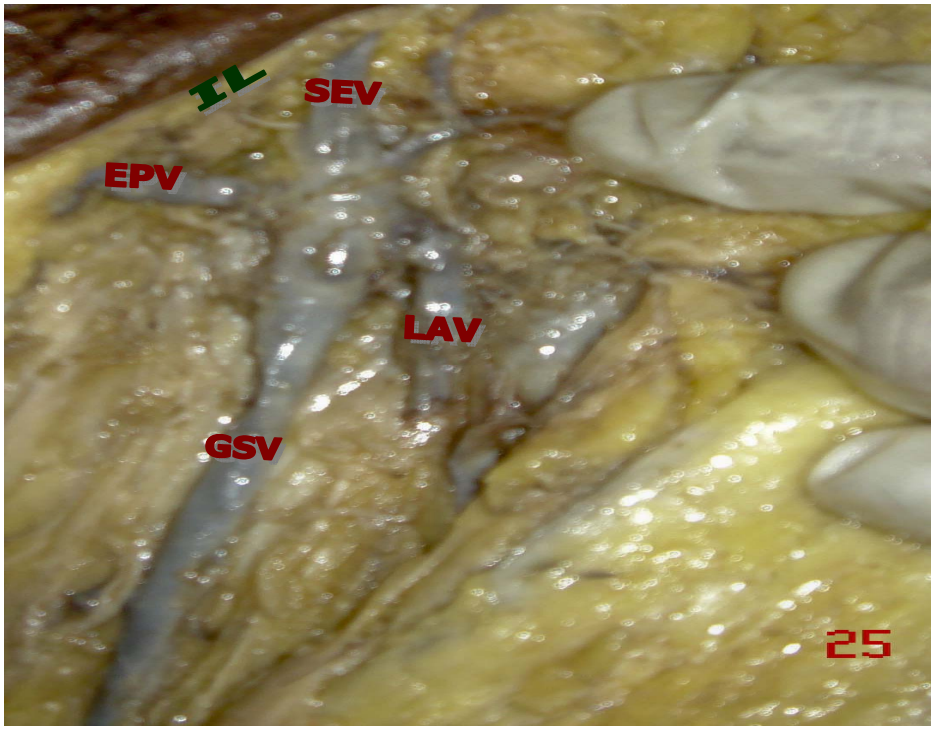
Picture 11 (Right Side)



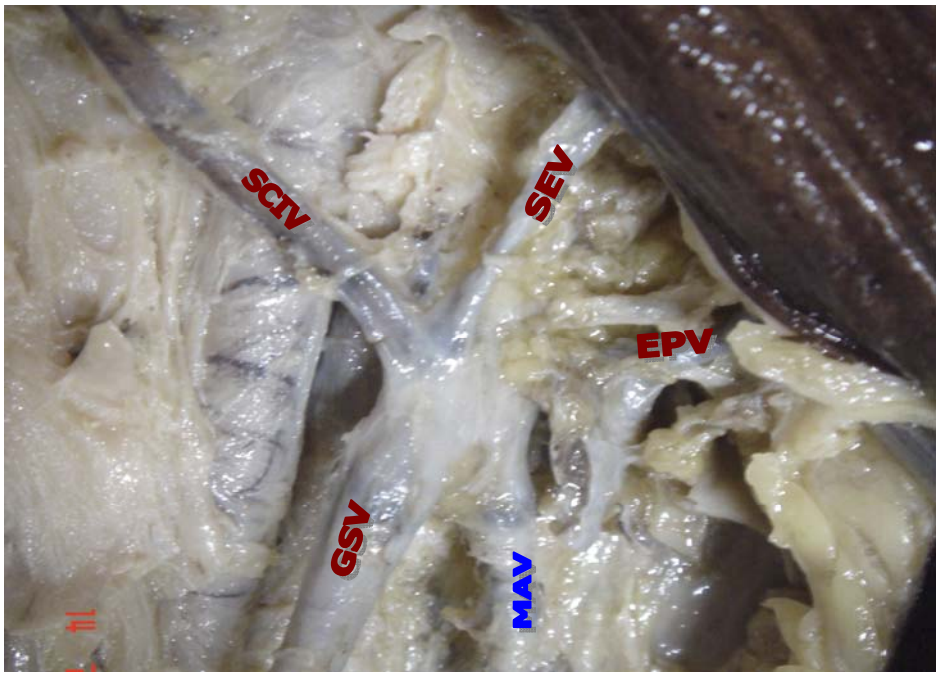
Picture 12 (Right Side)

Picture 11: Medial accessory saphenous vein drained in common with external pudendal vein.

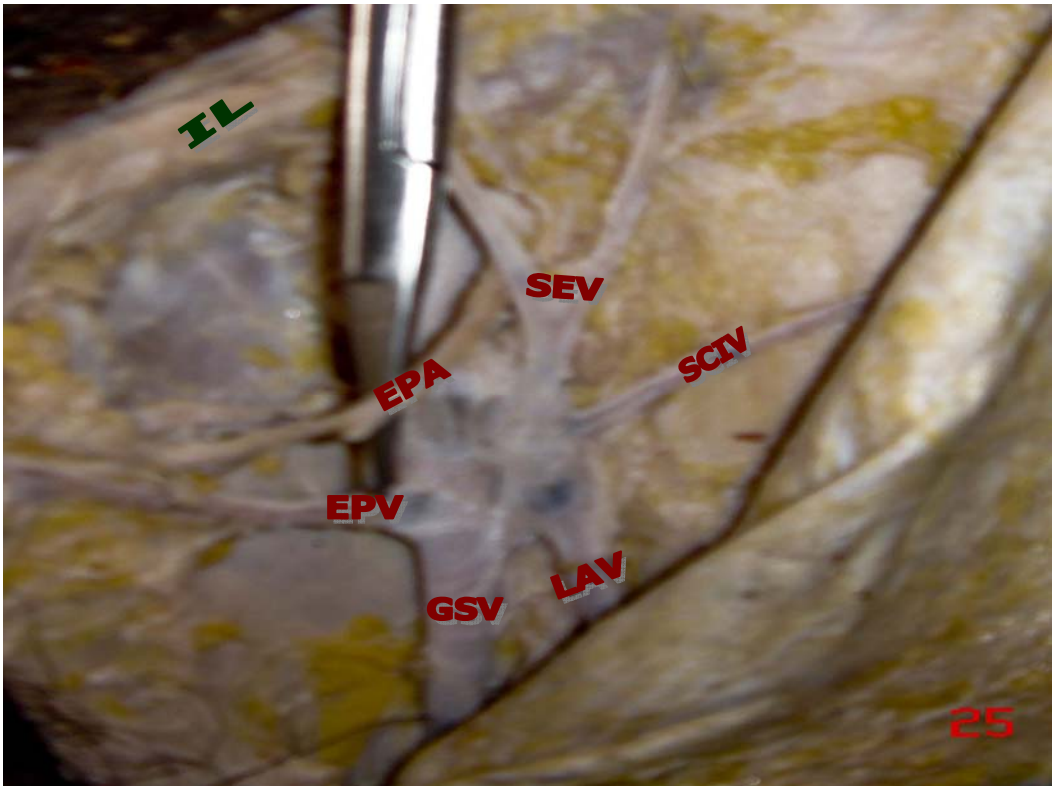
Picture 12: Medial accessory saphenous vein drained directly into Great Saphenous vein below fossa ovalis.



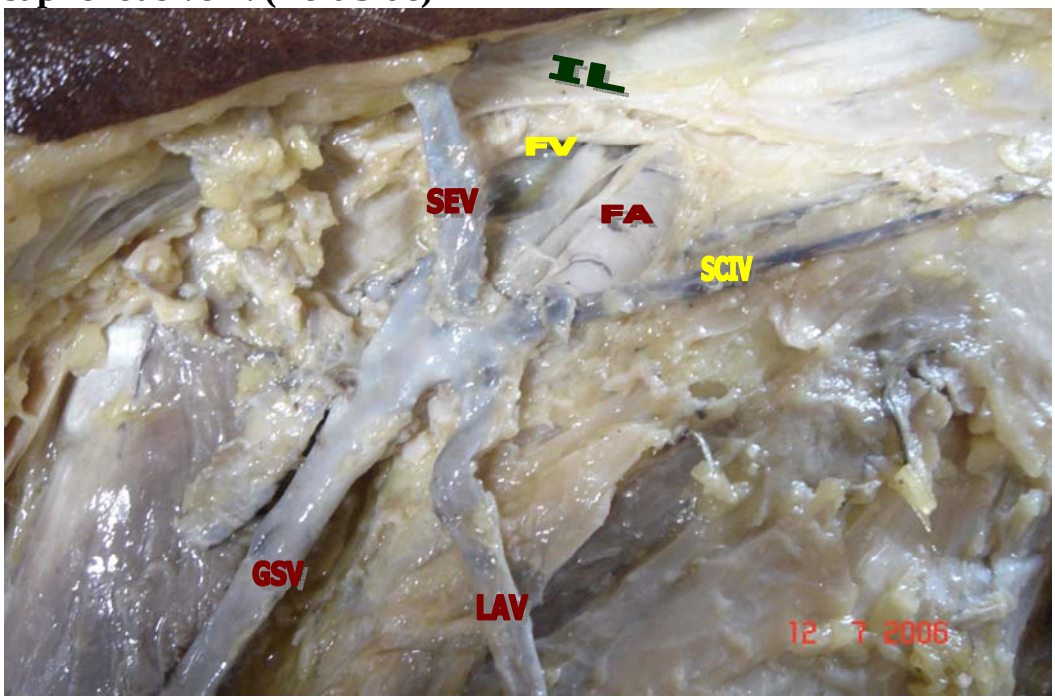
Picture 13: Superficial epigastric vein drained directly into Great saphenous vein. (Left Side)



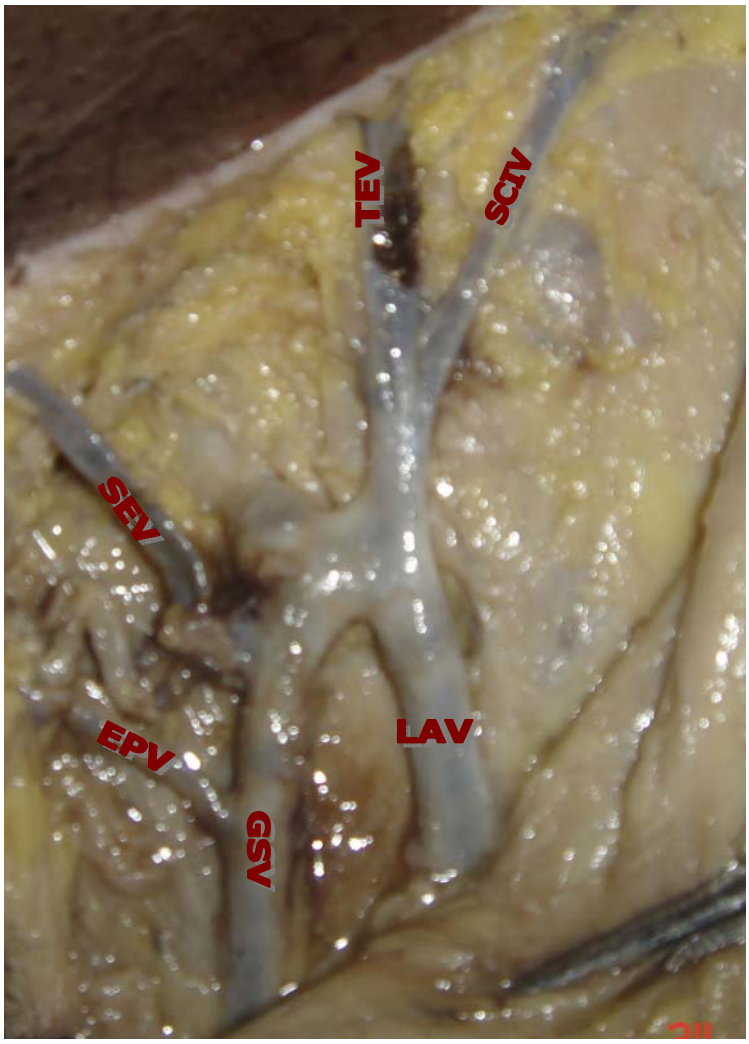
Picture 14: Superficial epigastric vein drained in common with superficial circumflex iliac vein into Great saphenous vein. (Right Side)



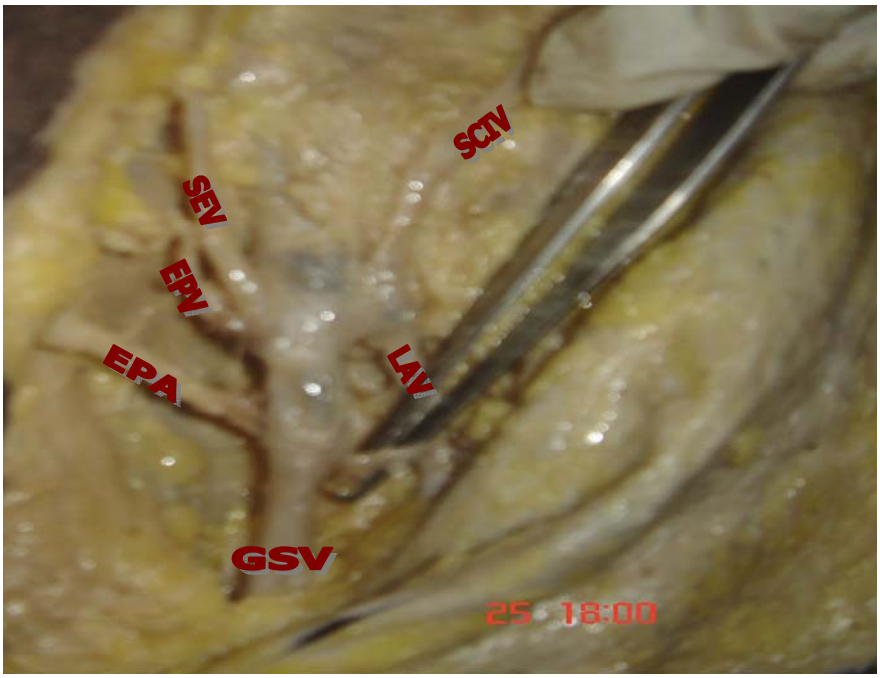
Picture 15: Superficial circumflex iliac vein drained directly into Great saphenous vein. (Left Side)



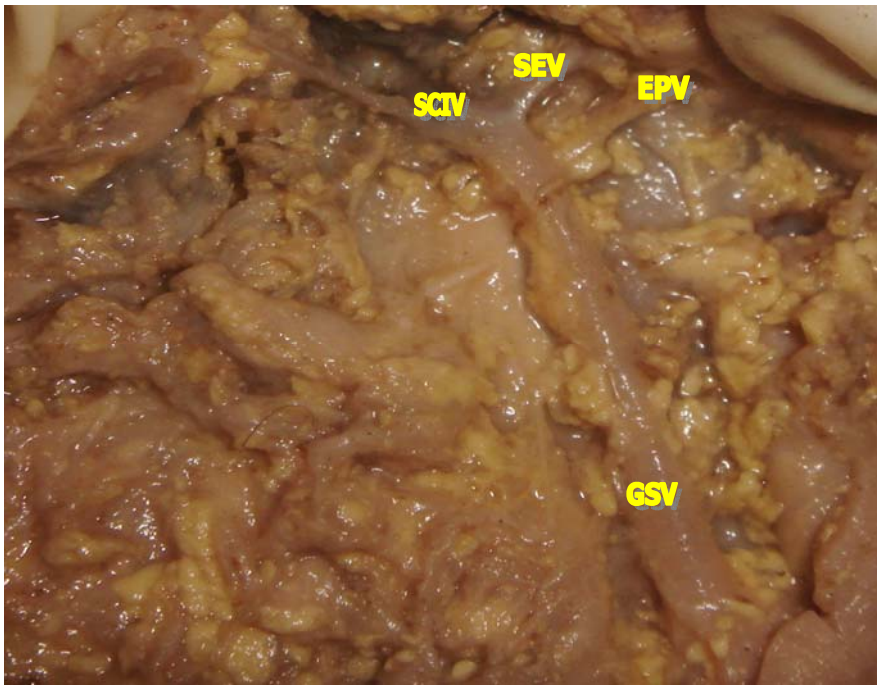
Picture 16: Superficial circumflex iliac vein drained in common with Lateral accessory saphenous vein. (Left Side)



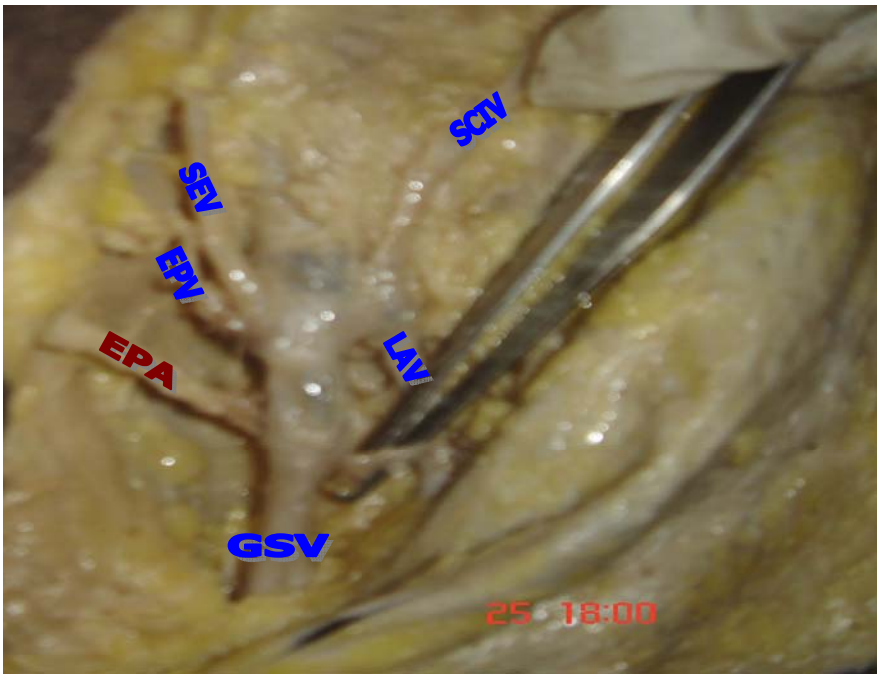
Picture 17: Superficial circumflex iliac vein drained in common with Lateral accessory saphenous vein and thoraco epigastric vein. (Left Side)



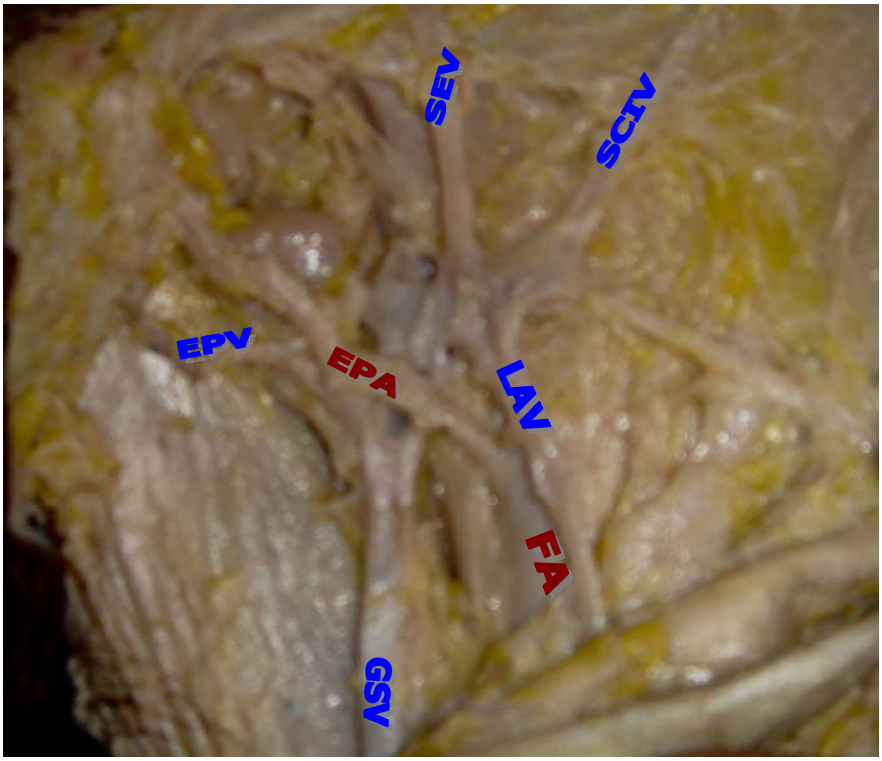
Picture 18: Superficial epigastric vein drained in common with superficial external pudendal vein into Great saphenous vein. (Left Side)



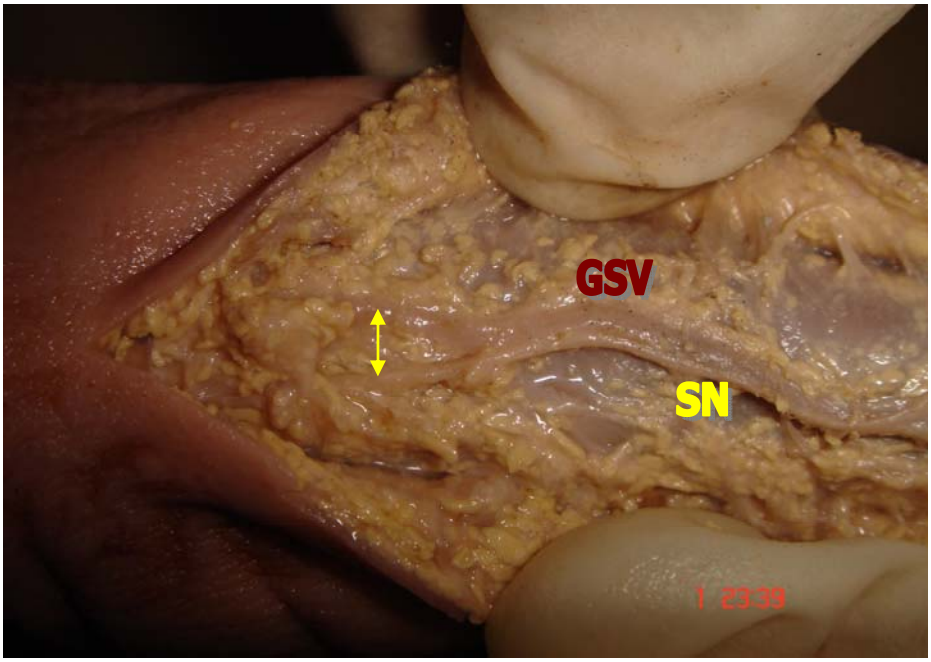
Picture 19: Peri inguinal tributaries of Great saphenous vein dissected in foetus. (Right Side)



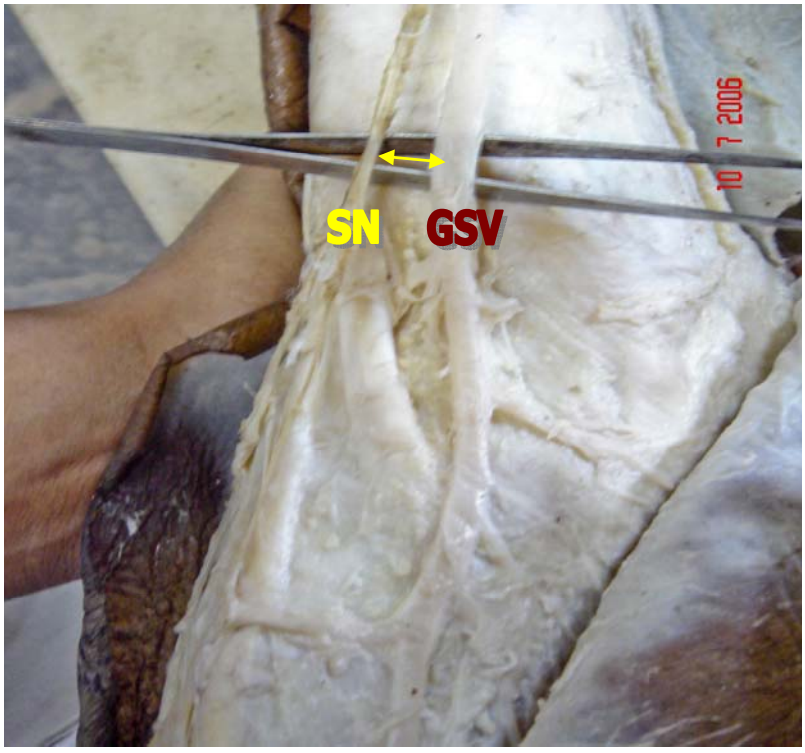
Picture 20: External pudendal artery is posterior to Great saphenous vein. (Left Side)



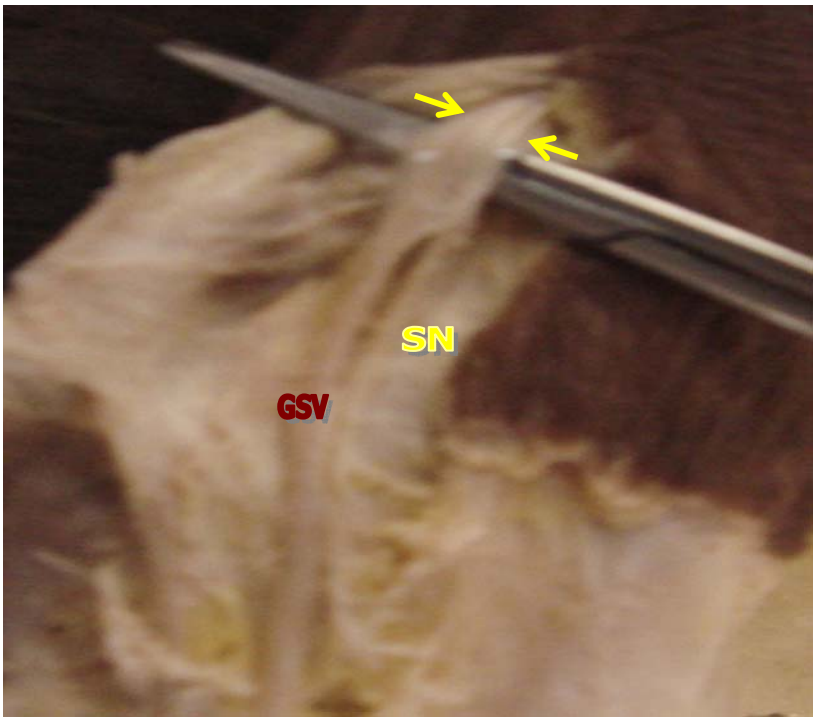
Picture 21: External pudendal artery is anterior to Great saphenous vein. (Left Side)



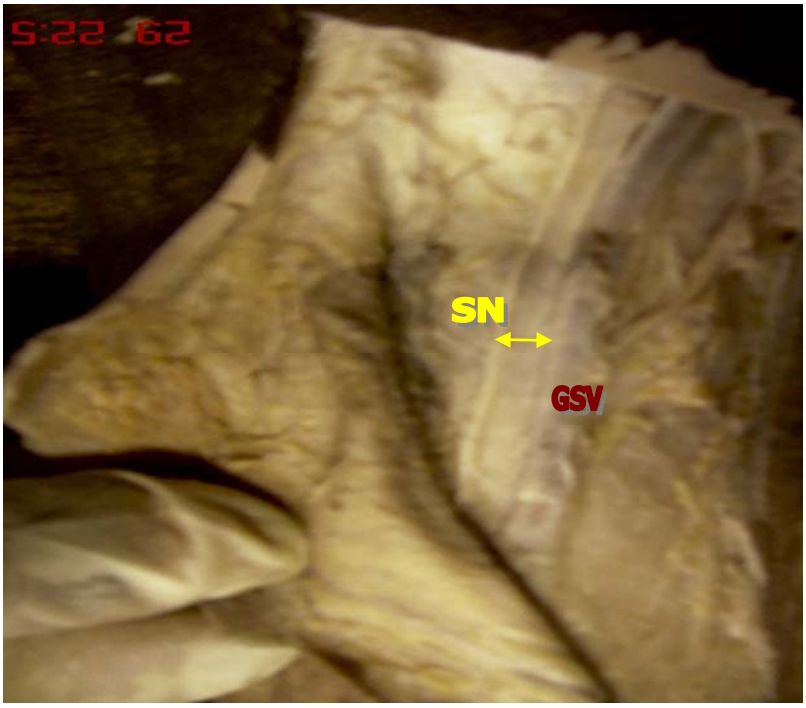
Picture 22: Saphenous nerve and Great saphenous vein came together below knee after which they were inseparable.



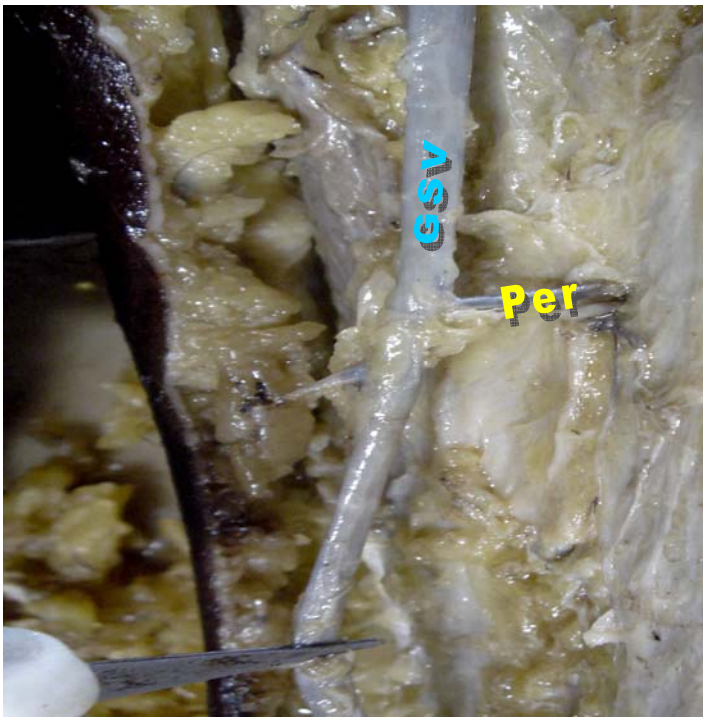
Picture 23: Saphenous nerve and Great saphenous vein separated just above medial malleolus. (Right Leg)



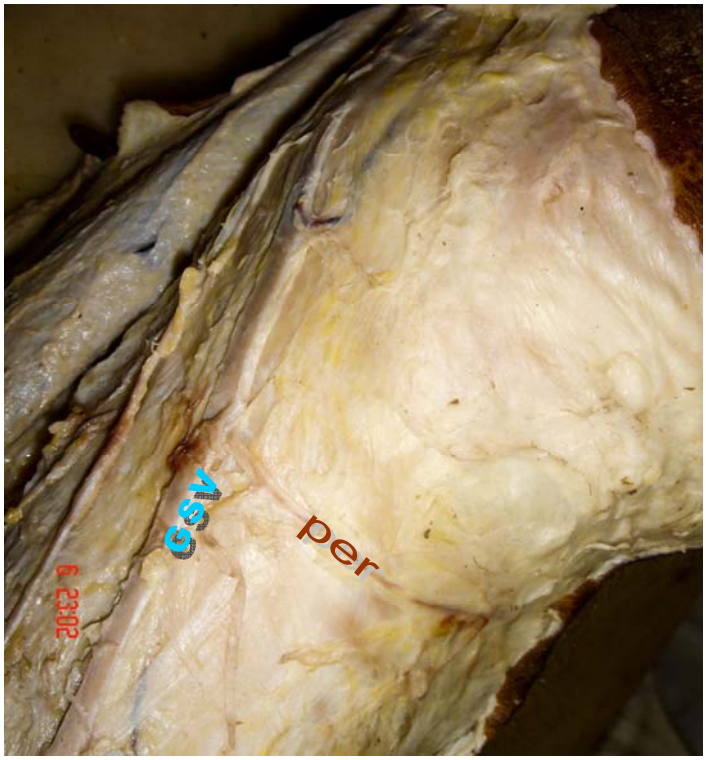
Picture 24: Saphenous nerve and Great saphenous vein were inseparable throughout.



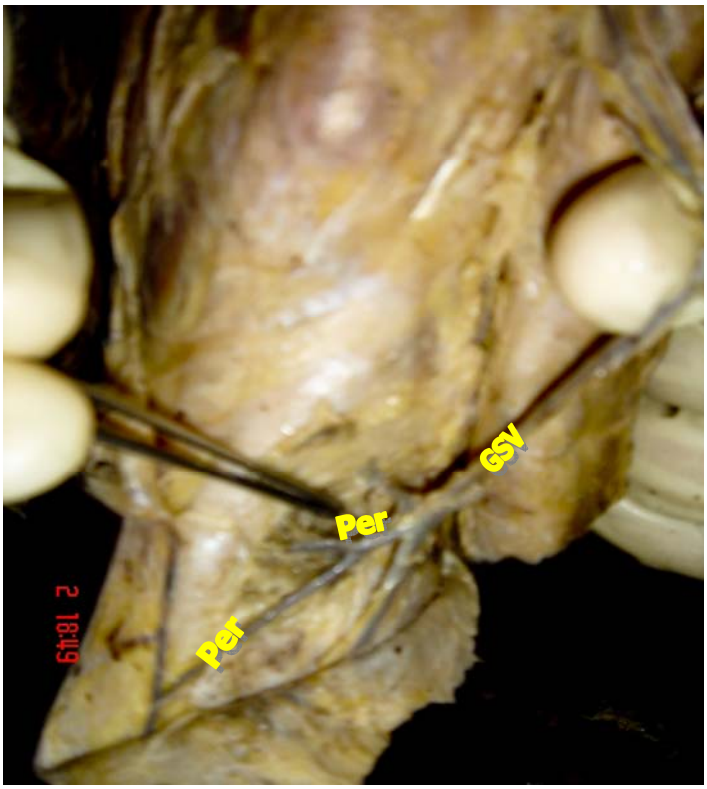
Picture 25: Saphenous nerve and Great saphenous vein were separate throughout.



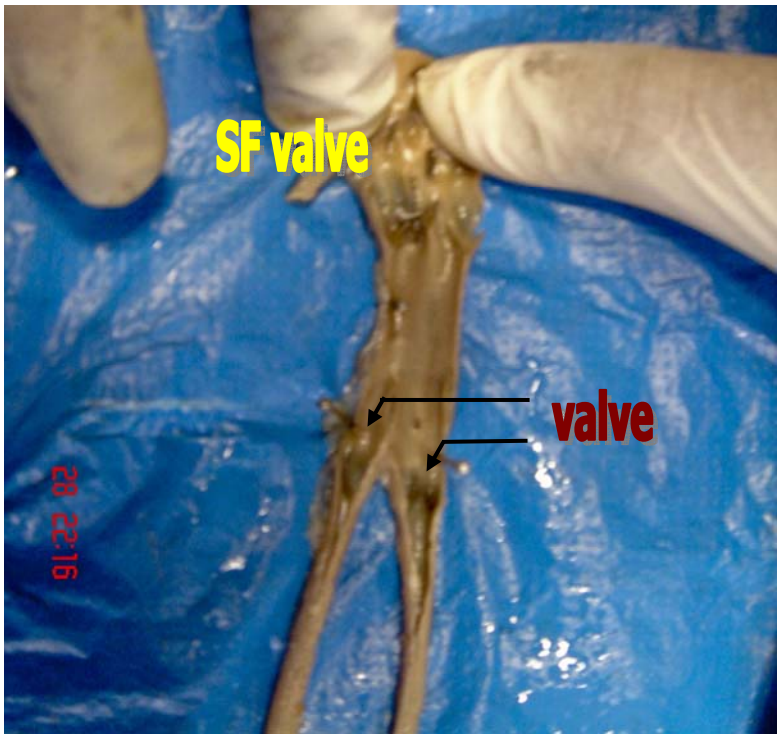
Picture 26: Perforator of Great saphenous vein in thigh.



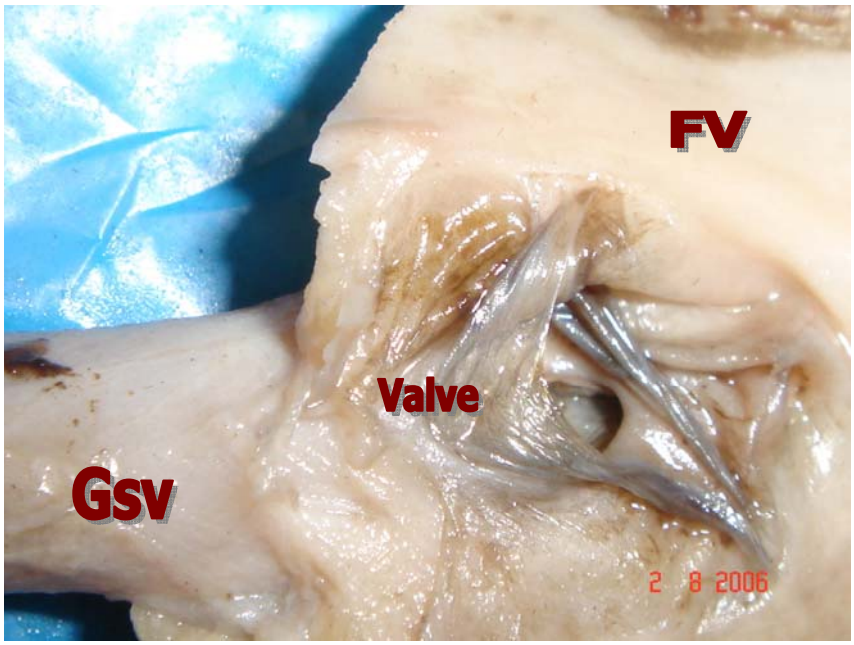
Picture 27: Perforator of Great Saphenous vein below the knee.



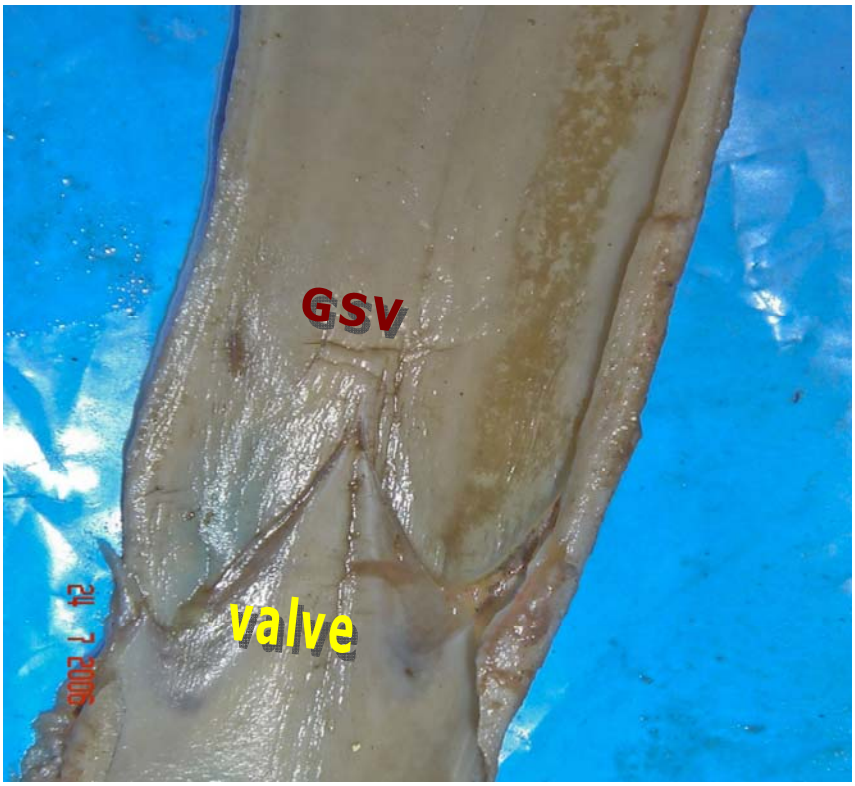
Picture 28: Ankle perforators of Great saphenous vein.



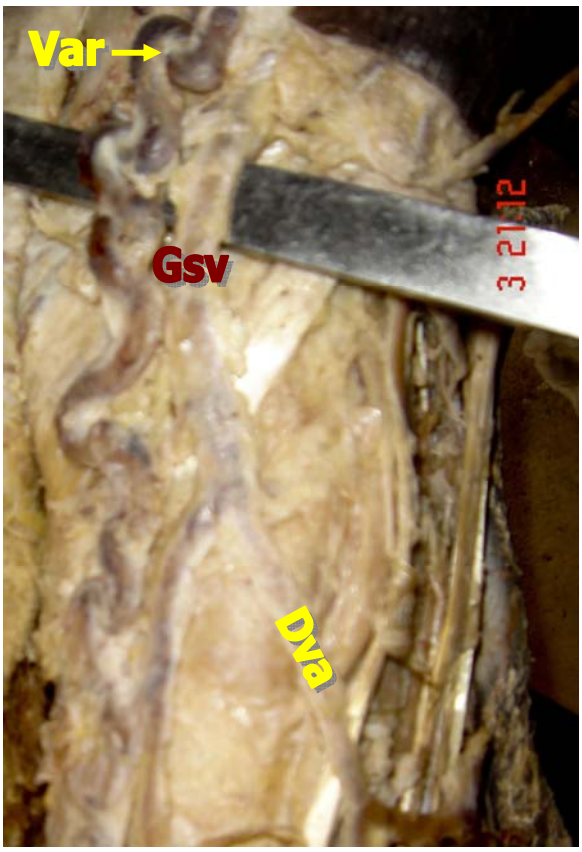
Picture 29: Valves in a bifid Great saphenous vein.



Picture 30: Valve at the sapheno-femoral junction.



Picture 31: Valve in Great saphenous vein with its bicuspid nature.

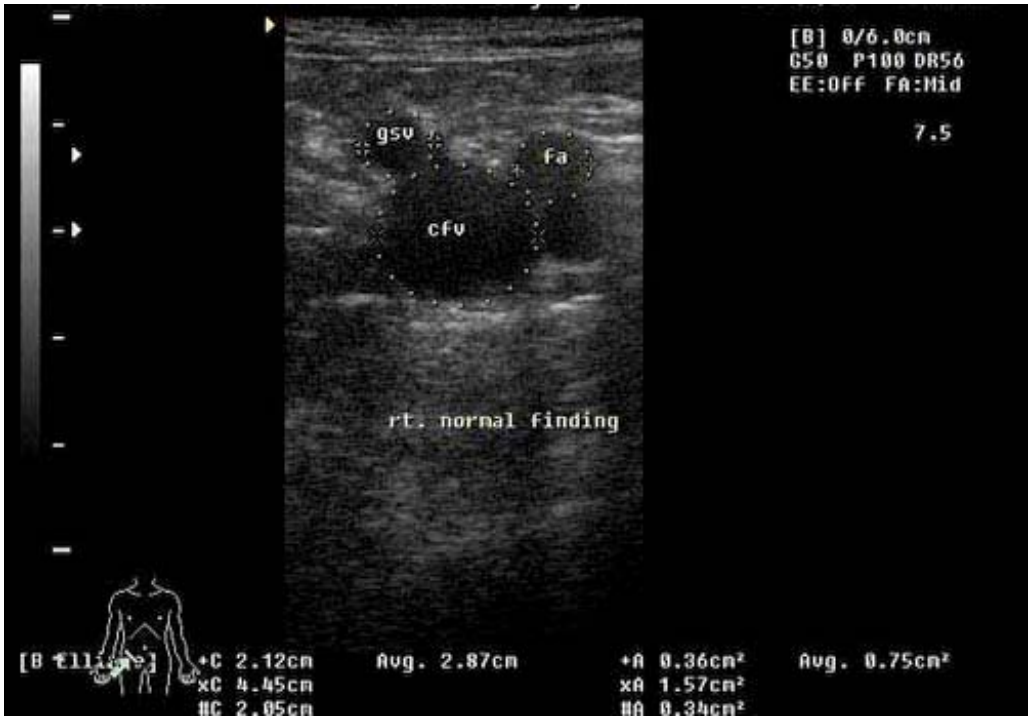


Picture 32

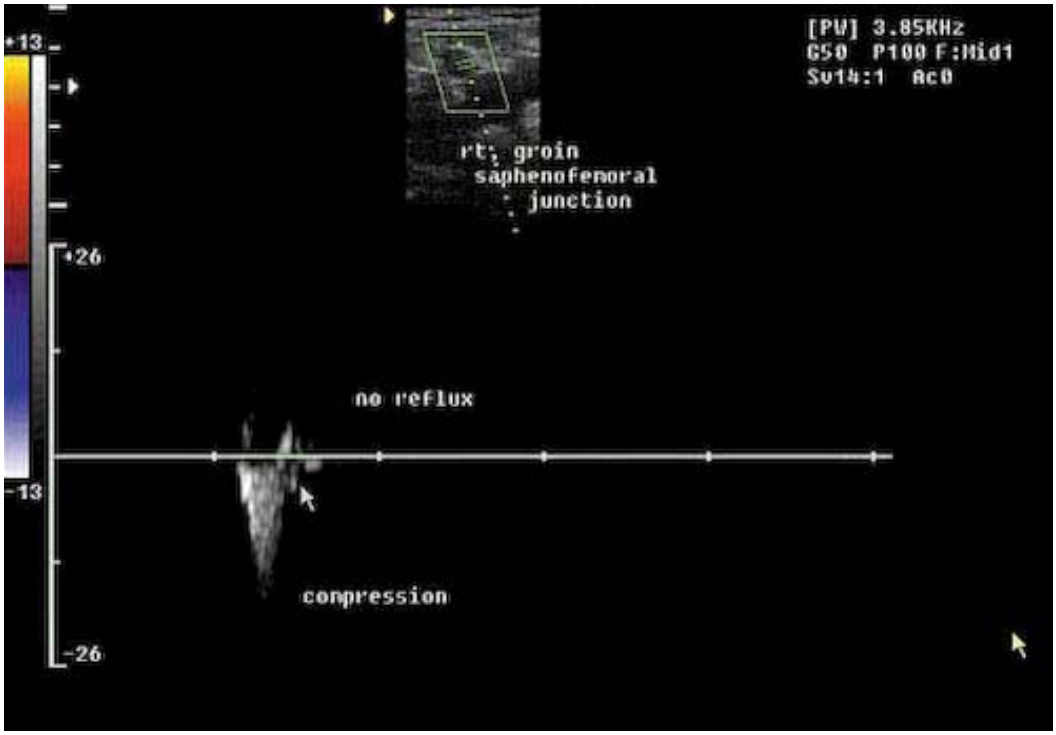
Picture 33

Picture 32: Varicosity of medial marginal vein.

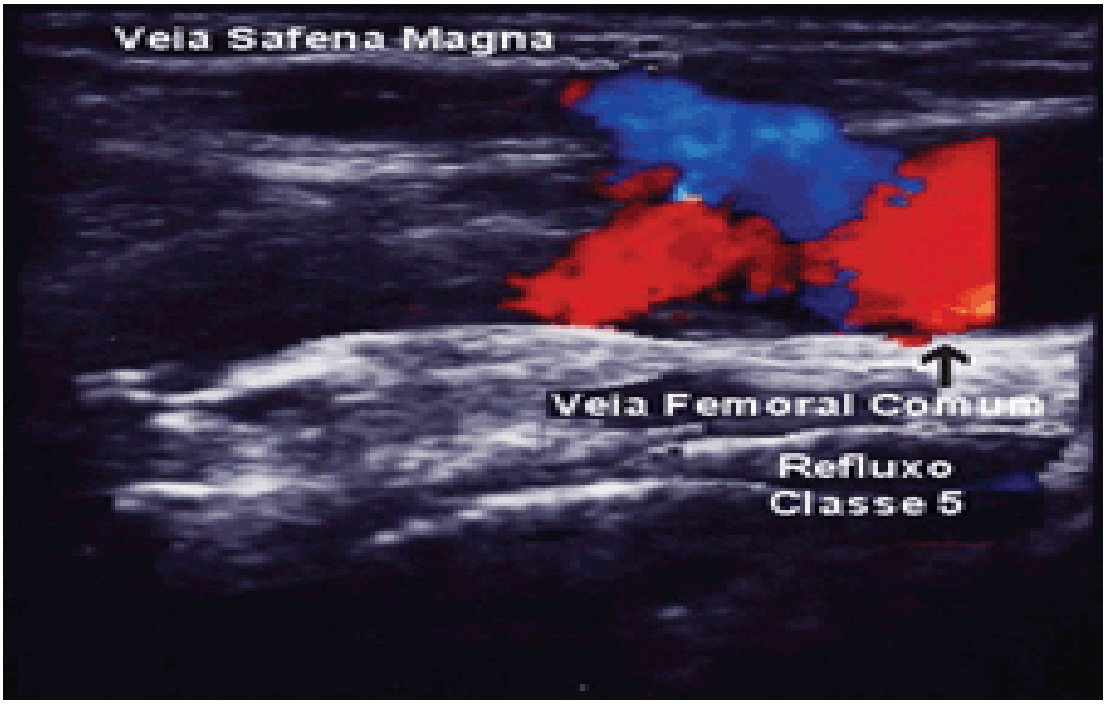
Picture 33: A bifid Great saphenous vein.



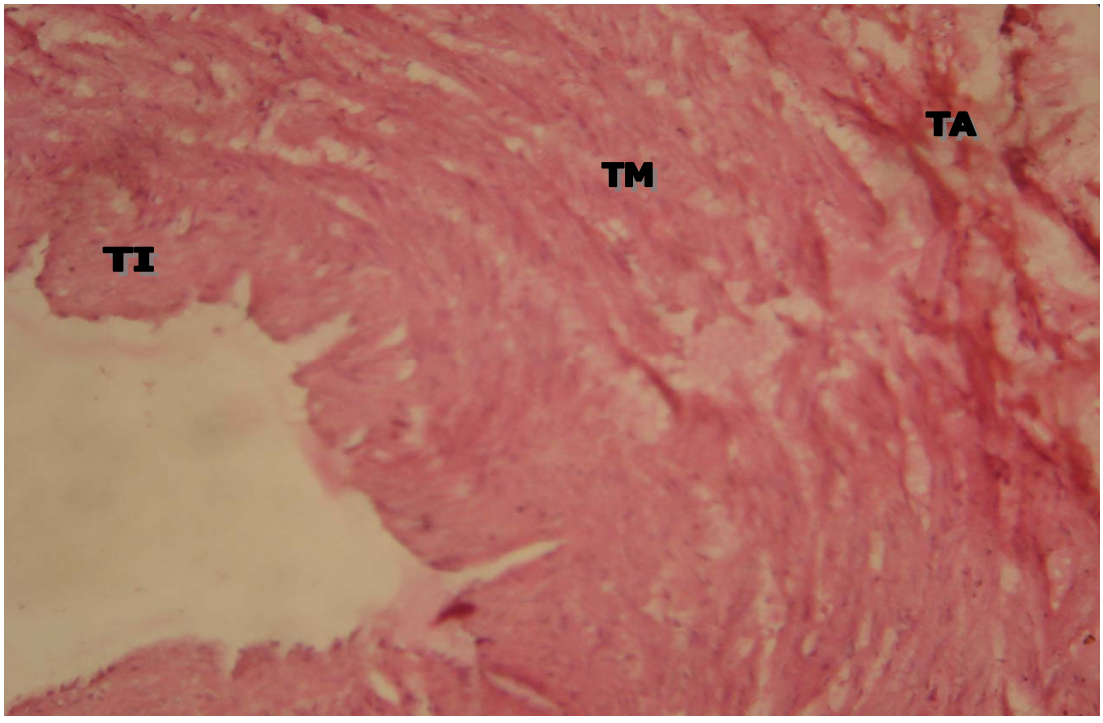
Picture 34: Duplex ultrasound scanning of Great saphenous vein.



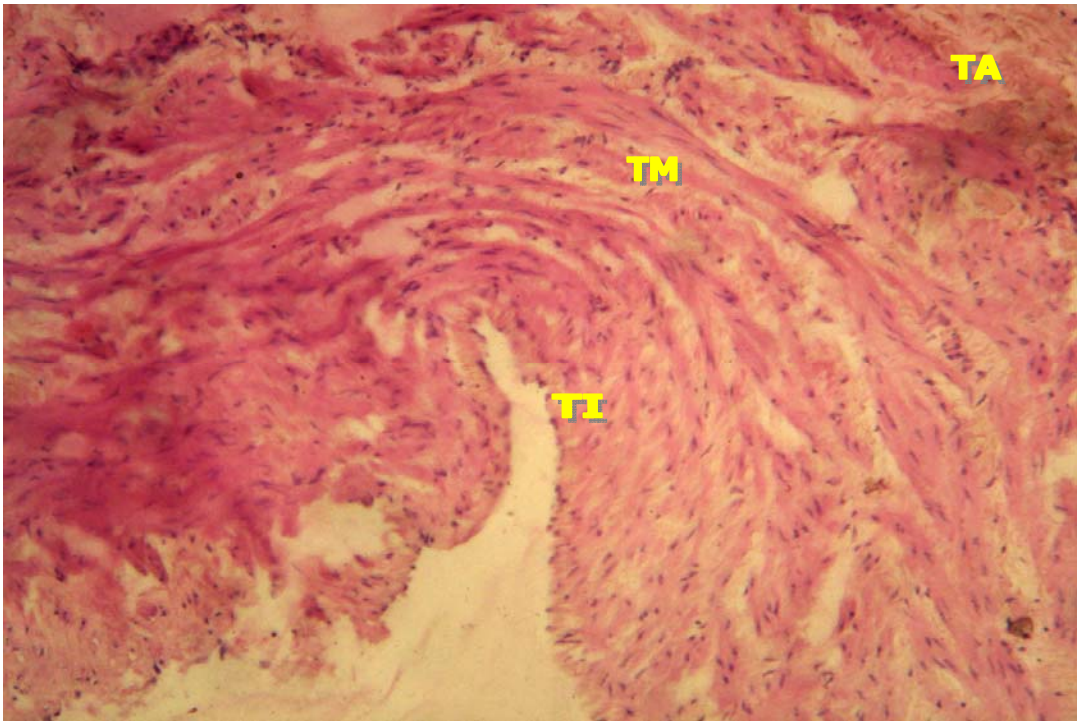
Picture 35: Duplex ultrasound scanning at sapheno-femoral junction.



Picture 36: Colour Doppler scanning of Great saphenous vein.



Picture 37: Low power view of Long Saphenous Vein (H & E Stain)



Picture 38: Low power view of Long Saphenous Vein (H & E Stain)

Picture 39: Low power view of Long Saphenous Vein (H & E Stain)

Table – 1

Observations of Glasser (1943):

1.	**TYPE – I A**	**37 %**
2.	TYPE – I B	6 %
3.	TYPE – I C	2 %
4.	TYPE – I D	2 %
5.	TYPE – II A	6 %
6.	TYPE – II B	9 %
7.	TYPE – II C	9 %
8.	TYPE – II D	2 %
9.	TYPE – III A	1 %
10.	TYPE – III B	3 %
11.	TYPE – III C	3 %
12.	TYPE – III D	1 %
13.	TYPE – IV A	6 %
14.	TYPE – IV B	1 %
15.	TYPE – IV C	6 %
16.	TYPE – IV D	1 %
17.	TYPE – V A	1 %
18.	TYPE – V B	3 %
19.	TYPE – V C	1 %

Table – 2

Observations of Daseler (1946):

1.	TYPE – I a	15 %
2.	TYPE – II b	15 %
3.	TYPE – III c	13 %
4.	TYPE – IV d	6 %
5.	TYPE – V e	8 %
6.	TYPE – VI f	33 %
7.	TYPE – VII g	2 %
9.	TYPE – VIII h	8%

Table – 3

Observations of Jorgen et al (1988):

Types	1	2	3	4
Number	41	10	7	2
Percentage	68.3 %	17 %	11.6 %	3.1 %

Table – 4

Formation of Great Saphenous Vein:

Type	No. of Specimens	Percentage
A. Union of medial end of Dorsal venous arch and Medial marginal vein.	26	52
B. Continuation of Medial end of dorsal venous arch	18	36
C. Union of medial end of dorsal and medial dorsal vein of Great toe	6	12

Table – 5

Length of the Great Saphenous Vein in Leg in cm:

S. No:	Gender	Length - cms Right side	Length – cms Left side
1	F	30.5	33.1
2	M	37.1	37.5
3	M	34.5	33.2
4	M	35.5	34.5
5	M	35.1	34.7
6	F	31.0	32.2
7	M	36.5	39.5
8	F	34.0	36.1
9	M	36.2	33.2
10	F	34.1	31.1
11	M	32.0	34.1
12	M	35.2	34.2
13	M	35.5	36.4
14	F	31.5	32.0
15	F	32.0	31.4
16	M	36.2	34.6
17	M	35.4	36.5
18	M	34.5	36.1
19	F	34.2	36.4
20	M	32.7	34.1
21	M	37.2	35.2
22	M	39.7	40.0

Table – 6

Length Of the Great Saphenous Vein in thigh in cm:

S. No:	Gender	Length - cms Right side	Length – cms Left side
1	F	32.1	31.5
2	M	36.5	37.6
3	M	32.8	32.0
4	M	33.4	33.1
5	M	32.5	33.0
6	F	32.0	33.2
7	M	35.1	36.3
8	F	35.3	36.1
9	M	34.3	36.0
10	F	31.5	32.0
11	M	34.1	36.4
12	M	34.5	34.2
13	M	36.2	37.1
14	F	34.1	33.0
15	F	30.0	30.5
16	M	34.5	35.5
17	M	36.2	37.2
18	M	34.1	33.2
19	F	31.1	32.4
20	M	34.5	32.6
21	M	35.4	36.4
22	M	39.0	41.0

Table – 7

Total Length of Great Saphenous Vein in cm:

S. No:	Gender	Length - cm Right side	Length – cm Left side
1	F	62.6	64.6
2	M	73.6	75.1
3	M	67.3	65.2
4	M	68.9	67.6
5	M	67.6	67.1
6	F	63.0	65.4
7	M	71.6	75.8
8	F	69.3	72.2
9	M	70.5	69.2
10	F	65.6	63.0
11	M	66.1	70.5
12	M	69.7	68.4
13	M	71.7	73.5
14	F	65.6	65.0
15	F	62.0	61.9
16	M	70.7	71.1
17	F	71.6	73.7
18	M	68.6	69.3
19	F	65.3	68.8
20	M	67.2	66.7
21	M	72.6	71.6
22	M	78.7	81.0

Table – 8

Length of Great Saphenous Vein in Foetus in cm:

Length of Great Saphenous Vein in Leg

S. No:	Length - cms Right side	Length – cms Left side
23	7.1	7.3
24	6.9	6.5
25	7.2	7.5

Length of Great Saphenous Vein in Thigh.

S. No:	Length - cms Right side	Length – cms Left side
23	6.5	6.4
24	7.1	6.9
25	6.7	6.5

Total length of Great Saphenous Vein.

S. No:	Length - cms Right side	Length – cms Left side
23	13.6	13.7
24	14.0	13.4
25	13.9	14.0

Table – 9

Diameter of Great Saphenous Vein in Thigh:

S. No:	Gender	Diameter - cm Right side	Diameter – cm Left side
1	F	0.2	0.3
2	M	0.4	0.2
3	M	0.3	0.2
4	M	0.3	0.4
5	M	0.25	0.3
6	F	0.4	0.3
7	M	0.3	0.2
8	F	0.4	0.3
9	M	0.3	0.2
10	F	0.2	0.4
11	M	0.3	0.2
12	M	0.2	0.3
13	M	0.4	0.25
14	F	0.3	0.3
15	F	0.4	0.3
16	M	0.25	0.3
17	M	0.4	0.3
18	M	0.3	0.25
19	F	0.2	0.3
20	M	0.3	0.4
21	M	0.2	0.25
22	M	0.3	0.25

Table – 10

Diameter of Great Saphenous Vein in Leg:

S. No:	Gender	Diameter - cm Right side	Diameter – cms Left side
1	F	0.3	0.45
2	M	0.4	0.3
3	M	0.5	0.4
4	M	0.3	0.4
5	M	0.45	0.35
6	F	0.4	0.4
7	M	0.5	0.45
8	F	0.35	0.5
9	M	0.4	0.3
10	F	0.4	0.4
11	M	0.4	0.5
12	M	0.5	0.45
13	M	0.4	0.3
14	F	0.3	0.4
15	F	0.35	0.4
16	M	0.4	0.45
17	M	0.4	0.4
18	M	0.3	0.4
19	F	0.4	0.35
20	M	0.3	0.4
21	M	0.4	0.5
22	M	0.3	0.4

Table – 11

Diameter of Great Saphenous Vein in Foetus:

Diameter of Great Saphenous Vein in Leg

S. No:	Diameter - cms Right side	Diameter – cms Left side
23	0.06	0.05
24	0.1	0.1
25	0.07	0.06

Diameter of Great Saphenous Vein in Thigh

S. No:	Diameter - cms Right side	Diameter – cms Left side
23	0.05	0.04
24	0.05	0.06
25	0.05	0.05

Table – 12

LEVEL OF TERMINATION

S. No	Right			Left		
	A.S.I.S - cm	P.T - cm	Ing.Lig - cm	A.S.I.S - cm	P.T - cm	Ing.Lig - cm
1	9.2	4	1.8	8.5	3.1	2
2	9.8	3.5	3.4	11	4	3.6
3	9.5	5.1	5	10.5	3.8	2.8
4	10.7	4	4.7	12	2.9	4.5
5	10.1	3.5	3.1	10.9	4.0	2.4
6	10.2	5.2	3	9.5	5.1	2.0
7	9.1	4.5	5.0	10.1	4.0	3.0
8	10.1	4.1	3.1	10.2	4.1	2.1
9	9.4	3.1	2.3	9.1	3.4	3.0
10	10.5	3.2	2.5	11.0	4.0	3.5
11	10.4	4.1	1.9	9.8	3.9	2.4
12	9.1	3.5	4.0	10.5	3.8	4.9
13	10.8	4.2	3.1	10.2	3.9	3.4
14	9.4	3.2	5.1	10.2	3.7	3.1
15	9.8	3.7	3.2	9.5	3.9	4.1
16	8.7	4.3	2.3	9.4	4.1	3.1
17	9.1	3.1	3.1	8.9	3.9	3.9
18	9.2	2.8	2.1	9.4	3.2	1.8
19	10.2	3.4	2.3	10.8	3.1	2.5
20	11.1	4.1	3.2	10.2	5.0	2.4
21	9.4	4.3	2.8	10.2	4.1	2.2
22	9.3	3.9	3.1	9.5	3.5	2.5

Foetus

23	3.1	1.2	0.7	3.2	1.4	0.8
24	2.5	0.8	0.6	2.4	0.9	0.7
25	2.6	0.7	0.6	2.9	0.8	0.7

A.S.I.S – Anterior Superior Iliac Spine.
P.T – Pubic Tubercle.
ING.LIG – Inguinal Ligament.

Table – 13

LEVEL OF TERMINATION WITH RESPECT TO PUBIC TUBERCLE:

Distance from pubic tubercle	No. of cases	Percentage
1. < 3 cm Lateral	2	4
2. 3 -5 cm Lateral	40	90
3. > 5 cm Lateral	3	6

Table – 14

DRAINAGE PATTERN OF LATERAL ACCESSORY GREAT SAPHENOUS VEIN:

1. At fossa ovalis

S. No	Drainage into Great Saphenous vein	No: of cases	Percentage
1	Directly	19	38
2	In common		
a	*With superficial circumflex iliac and superficial epigastric veins*	18	36
b	*With superficial circumflex iliac vein only*	6	12
c	*With Thoracoepigastric and circumflex iliac veins*	1	2

2. Below fossa ovalis

3	Directly	6	12

Table – 15

DRAINAGE PATTERN OF MEDIAL ACCESSORY GREAT SAPHENOUS VEIN:

1. At fossa ovalis

S. No	Drainage into Great Saphenous vein	No: of cases	Percentage
1	Directly	3	6
2	Incommon		
a	*With External pudendal vein*	3	6

2. Below fossa ovalis

3	Directly	44	88

Table – 16

DRAINAGE PATTERN OF SUPERFICIAL EPIGASTRIC VEIN

S. No	Drainage into Great Saphenous vein	No: of cases	Percentage
1	Directly	25	50
2	In common		
a	*With superficial circumflex iliac and lateral accessory Great Saphenous veins*	18	36
b	*With External pudendal vein only*	2	4
c	*With superficial circumflex iliac only*	5	10

Table – 17

DRAINAGE PATTERN OF SUPERFICIAL CIRCUMFLEX ILIAC VEIN:

S. No	Drainage into Great Saphenous vein	No: of cases	Percentage
1	Directly	20	40
2	Incommon		
a	*With Superficial epigastric and lateral accessory veins*	18	36
b	*With Superficial epigastric vein only*	5	10
c	*With lateral accessory Great Saphenous vein only*	6	12
d	*With thoraco epigastric and lateral accessory Great Saphenous veins*	1	2

Table – 18

DRAINAGE PATTERN OF SUPERFICIAL EXTERNAL PUDENDAL VEIN:

S. No	Drainage into Great Saphenous vein	No: of cases	Percentage
1	Directly	45	90
2	In common		
a	*With superficial epigastric vein only*	2	4
b	*With medial accessory Great Saphenous vein only*	3	6

Table – 19

RELATIONSHIP OF EXTERNAL PUDENDAL ARTERY TO GREAT SAPHENOUS VEIN:

S. No	External Pudendal Artery	No of specimens	Percentage
1	External Pudendal Artery – *not visualised*	37	74
2	External Pudendal Artery – *Posterior*	8	16
3	External Pudendal Artery – *Anterior*	5	10

Table – 20

RELATIONSHIP OF SAPHENOUS NERVE TO GREAT SAPHENOUS VEIN:

S. No	Relationship of Saphenous nerve	No of cases	percentage
1	*Met below knee inseparable till medial malleolus.*	34	68
2	*Seperated few cms above medial malleolus*	6	12
3	*Inseparable throughout*	9	18
4	*Separate throughout*	1	2

Table – 21

NUMBER OF PERFORATORS

S. No	Right		Left	
	No of Perforators in Thigh	No of Perforators in Leg	No of Perforators in Thigh	No of Perforators in Leg
1	1	3	2	2
2	2	1	1	3
3	1	2	1	4
4	1	3	1	2
5	1	4	1	2
6	1	2	1	3
7	1	3	2	1
8	1	4	1	2
9	2	1	2	1
10	1	3	1	2
11	1	2	1	2
12	1	3	1	3
13	1	2	1	2
14	1	2	1	4
15	1	2	1	2
16	2	1	1	2
17	1	2	1	3
18	1	3	1	2
19	1	4	1	3
20	1	3	1	4
21	1	2	2	1
22	1	2	1	2

Table – 22

NUMBER OF VALVES

S. No	Right Side			Left Side		
	Valves in Thigh	Valves in Leg	Total NO:	Valves in Thigh	Valves in Leg	Total NO:
1	4	5	9	3	5	8
2	5	5	10	2	6	8
3	4	7	11	3	6	9
4	3	5	8	3	5	8
5	2	5	7	4	5	9
6	2	5	7	3	6	9
7	3	6	9	4	7	11
8	3	5	8	3	4	7
9	3	4	7	2	5	7
10	4	5	9	3	4	7
11	4	6	10	4	5	9
12	3	4	7	4	4	8
13	4	5	9	5	4	9
14	5	7	12	4	6	10
15	5	4	9	4	7	11
16	3	5	8	3	5	8
17	2	6	8	4	5	9
18	3	5	8	3	4	7
19	3	4	7	3	3	6
20	3	5	8	4	5	9
21	3	6	9	3	4	7
22	3	4	7	3	5	8

Chart No – 1

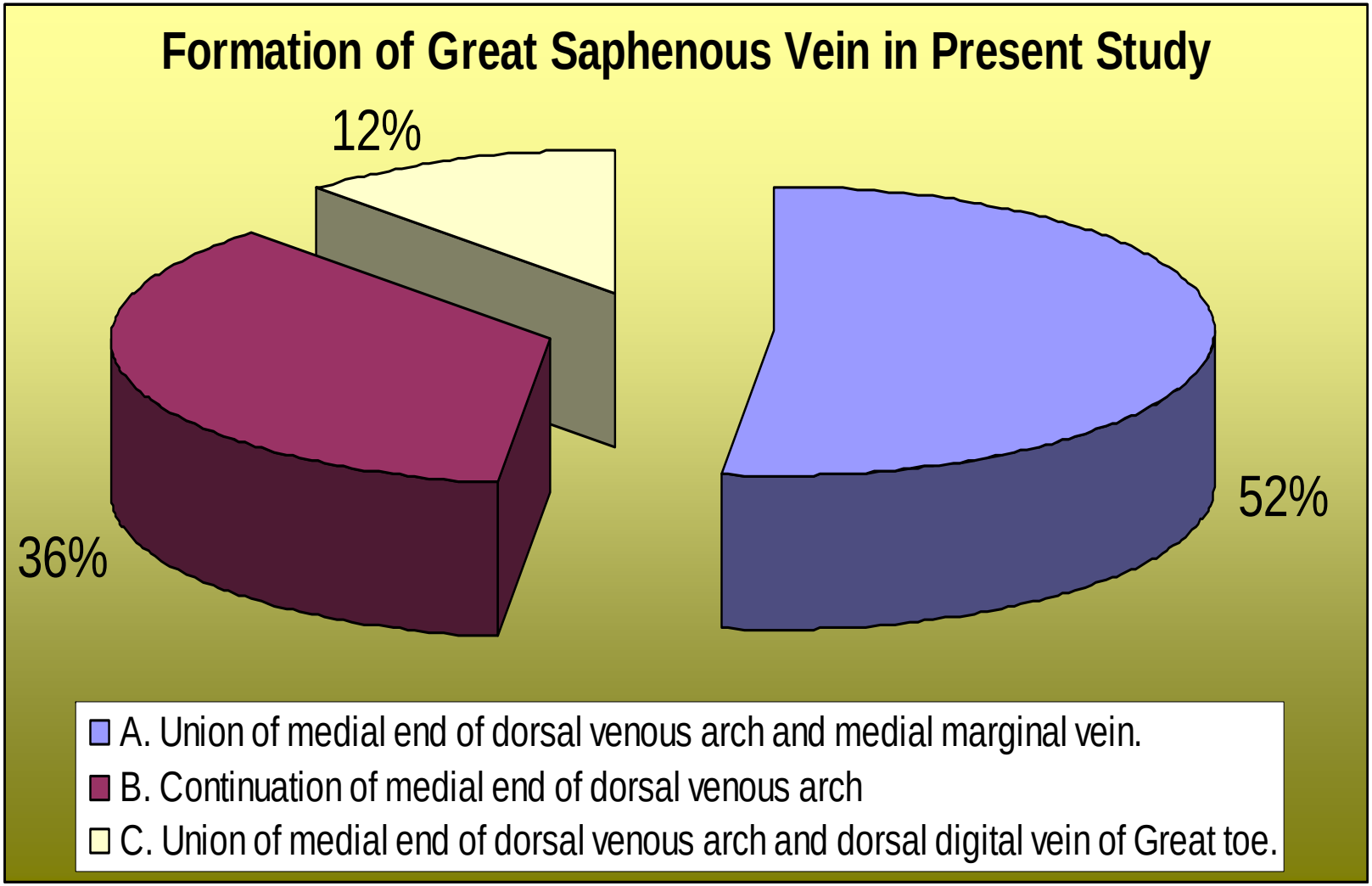

Formation of Great Saphenous Vein in Present Study
12%
36%
52%
A. Union of medial end of dorsal venous arch and medial marginal vein.
B. Continuation of medial end of dorsal venous arch
C. Union of medial end of dorsal venous arch and dorsal digital vein of Great toe.

Table – 23

LENGTH OF GREAT SAPHENOUS VEIN IN LEG

		Range in cms	Average in Males - cms	Average in Females - cms	Average - cms	Average in Right side - cms	Average in Left side - cms
Length of Great saphenous vein in Leg	**N J Papadopoulos (1981)**	31 - 37	34.9	33.8	34.5	--	--
	Present (2007)	30.5 – 40	35.53	32.82	34.68	34.57	34.79

LENGTH OF GREAT SAPHENOUS VEIN IN THIGH

		Range in cms	Average in Males - cms	Average in Females - cms	Average - cms	Average in Right side - cms	Average in Left side - cms
Length of Great saphenous vein in Thigh	**N J Papadopoulos (1981)**	30 – 37	34.6	33.2	34	--	--
	Present (2007)	30 – 41	35.14	32.48	34.29	34.05	34.55

TOTAL LENGTH OF GREAT SAPHENOUS VEIN

		Range in cms	Average in Males - cms	Average in Females - cms	Average - cms	Average in Right side - cms	Average in Left side - cms
Total length of Great saphenous vein	**N J Papadopoulos (1981)**	61 – 74	69.5	67.1	68.6	--	--
	Present (2007)	61.9 – 81	70.84	65.3	69.08	68.73	69.44

Table – 24

DIAMETER OF GREAT SAPHENOUS VEIN:

S. No	Author	Diameter - cms
1	Mahorner (1938)	0.5 - 2
2	Present (2007)	0.2 – 0.5

Table – 25

LEVEL OF TERMINATION OF GREAT SAPHENOUS VEIN DISTANCE FROM INGUINAL LIGAMENT

S. No	Author	Distance
1	Morris (1893)	3.7 cm
2	Howard.R.Mahorner (1938)	1 finger breadth
3	Basmajian (1952)	3 – 4 cms
4	Buchannan (1953)	1 ½ inches (3.81 cm)
5	G.J.Romanes (1964)	1 ½ inches (3.81 cm)
6	Mavor Galloway (1967)	3 – 4 cms
7	Abd.Ndiaye et al (2005)	4.19 cms
8	Present study (2007)	1.8 – 5.1 cm Average 2.9 cm

Table – 26

DISTANCE FROM PUBIC TUBERCLE:

S. No	Author	Distance
1	Henry Gray (1858)	2.5 – 3.5 cm
2	Basmajian (1952)	1.7 cm
3	Mavor Galloway (1967)	1.7 cm
4	Abd. diaye et al (2005)	3.83 cm
5	Present study (2007)	2.8 – 5.2 cm Average 3.84 cm

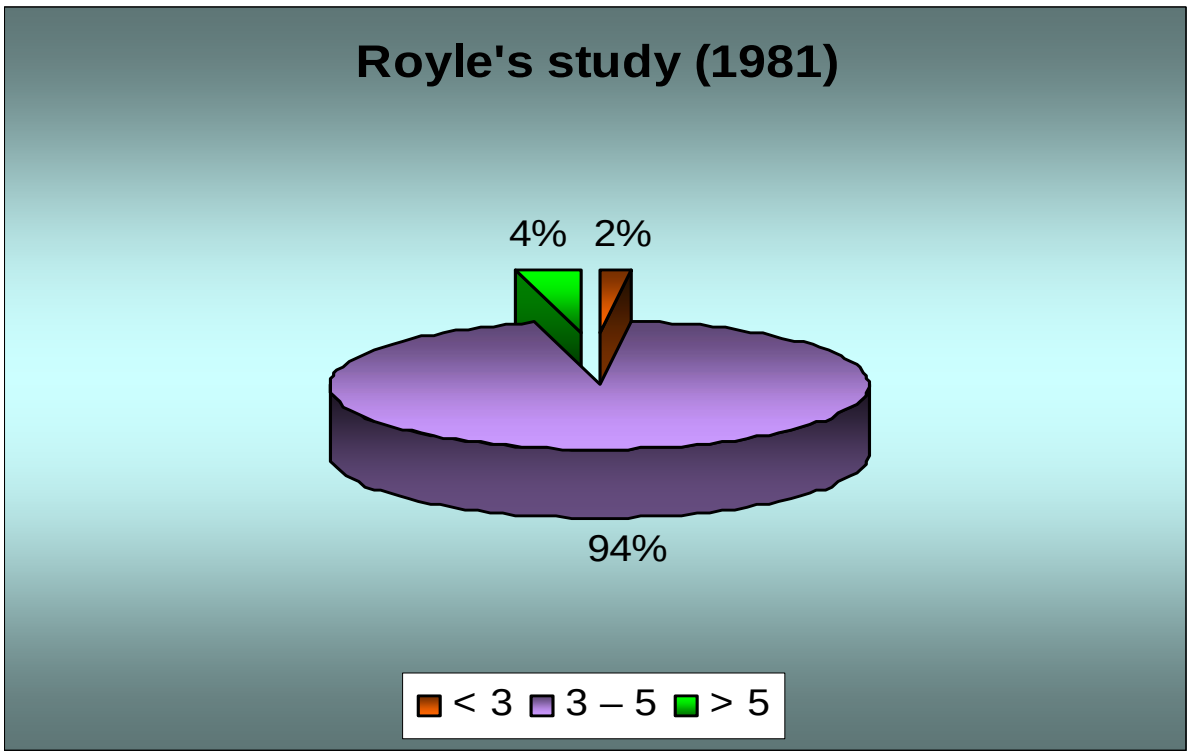
Table – 27

DISTANCE FROM PUBIC TUBERCLE

Comparison with Royle's study

S. No:	Distance in cm	Royle (1981)	Present (2007)
1	< 3	2 %	4 %
2	3 – 5	94 %	90 %
3	> 5	4 %	6 %

Chart No 2
Level of Termination from Pubic Tubercle



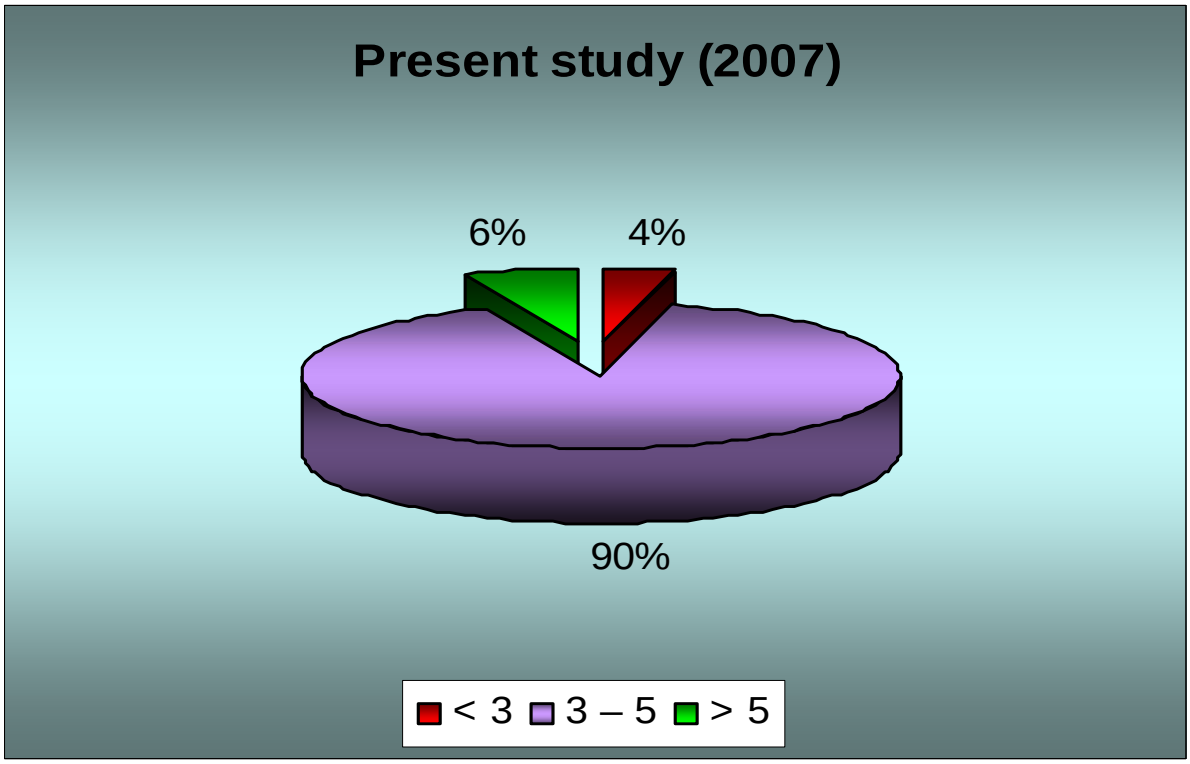


Table – 28

DRAINAGE PATTERN AT SAPHENO-FEMORAL JUNCTION COMPARISON WITH GLASSER'S STUDY (1943)

S. No:	Draining Pattern	Glasser (1943)	Present (2007)
I. A.	Superficial circumflex iliac vain, superficial external pudendal vein and Superficial epigastric veins drain at fossa ovalis directly and small, multiple veins like accessory saphenous and lateral superficial femoral vein draining into saphena magna far below fossa ovalis.	37 %	30 %
I. B.	Multiple divisions of the medial and lateral femoral veins of small caliber	6 %	--
I. C.	The large lateral superficial femoral vein drains into fossa ovalis. The inconstant thoraco epigastric vein drains into saphena magna	2 %	2 %
I. D.	The lateral superficial femoral and the accessory saphenous vein drains into fossa ovalis	2 %	6 %
II. A	The accessory saphenous vein forms a common stem with superficial external pudendal vein before joining saphenous vein	6 %	6 %
II. B.	Common trunk formed by the lateral superficial femoral vein, superficial circumflex iliac and superficial epigastric veins drain into fossa ovalis	9 %	36 %
II. C.	A common trunk formed by the lateral superficial femoral and the superficial circumflex iliac veins drain into fossa ovalis.	9 %	12 %

II. D.	The Superficial epigastric and superficial external pudendal vein form a common trunk. A large lateral superficial femoral vein is present.	2 %	4 %
III. A.	An accessory saphenous vein is present. Double superficial external pudendal veins present.	1 %	--
III. B.	Double superficial external pudendal veins drain into fossa ovalis.	3 %	--
III. C.	The superficial epigastric vein drains into vena saphena magna below the fossa ovalis.	3 %	--
III. D.	The superficial circumflex iliac vein drains into femoral vein	1 %	--
IV. A.	All high collateral veins drain directly into femoral vein	6 %	--
IV. B.	The lateral femoral and the superficial circumflex iliac veins form a common trunk. The other high collateral veins drain directly into the femoral vein.	1 %	--
IV. C.	The lateral femoral vein drains into the fossa ovalis. The superficial epigastric vein drains directly into the femoral vein.	6 %	--
IV. D.	The medial and lateral superficial femerol veins are multiple and of smaller caliber. The superficial circumflex iliac and the superficial external pudendal vein drain directly into the femoral vein.	1 %	--
V. A.	The lateral superficial femoral vein drains directly into the femoral vein.	6 %	--
V. B.	A double vena saphena magna with joining at fossa ovalis.	3 %	4 %
V. C	The saphena magna pierces the deep fascia to enter the femoral vein about 1 inch below the fossa ovalis.	1 %	--

Chart No 3
Drainage Pattern at Sapheno Femoral Junction

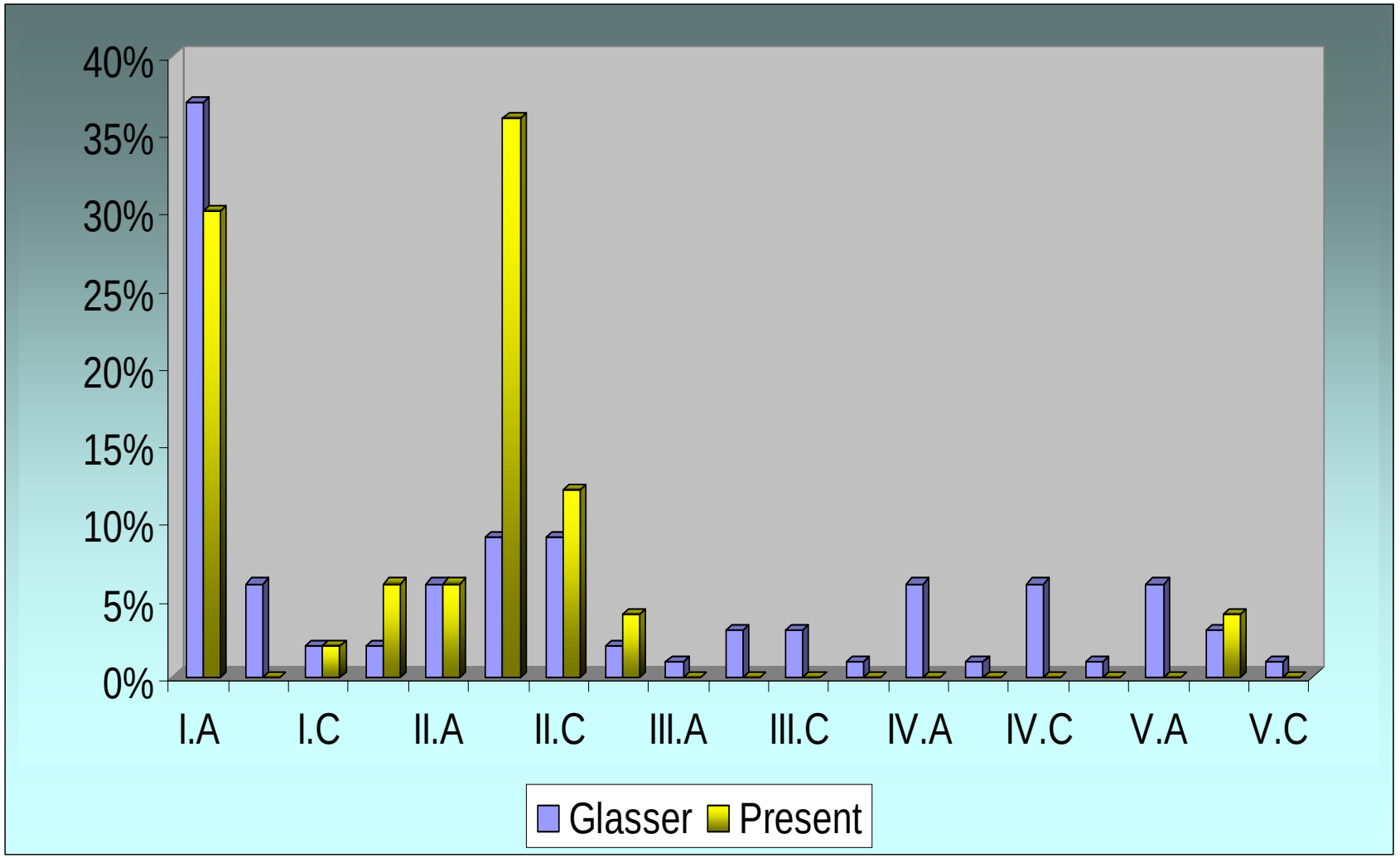
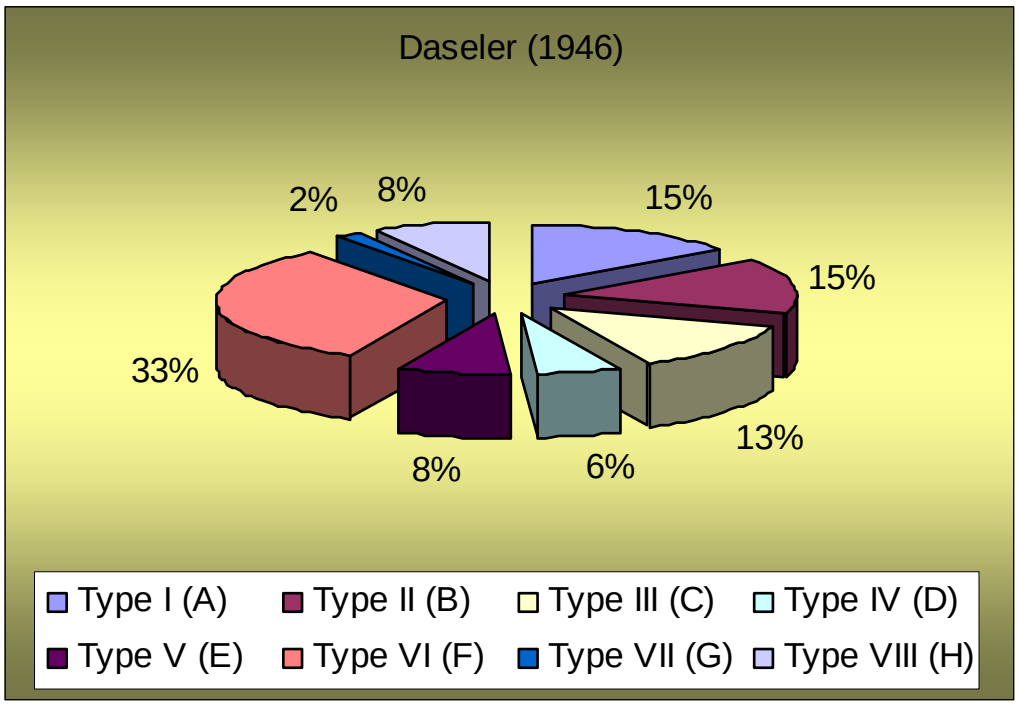


Table – 29

DRAINAGE PATTERN AT SAPHENO-FEMORAL JUNCTION COMPARISON WITH DASELER'S STUDY (1946)

S. No:	Drainage pattern	Daseler (1946)	Present (2007)
Type I (A)	Lateral accessory saphenous vein is constant tributary of larger size than other upper tributaries of the saphenous vein and some times larger than the great saphenous vein	15 %	30 %
Type II (B)	The superficial epigastric vein and superficial circumflex vein formed common trunk and drain into great saphenous vein at fossa ovalis. The other tributaries drained directly in to great saphenous vein.	15 %	10 %
Type III (C)	The circumflex iliac vein and the lateral accessory saphenous vein drained in to the great saphenous vein by a common trunk.	13 %	12 %
Type IV (D)	The superficial external pudendal vein and the superficial epigastric vein formed a common trunk and drained in to great saphenous vein.	6 %	4 %
Type V (E)	The medial accessory saphenous vein occurred as an unusual tributary at fossa ovalis and it drained in common with external pudendal vein.	8 %	6 %
Type VI (F)	The lateral superficial accessory vein, superficial circumflex iliac vein and superficial epigastric vein drained in to the great saphenous vein by a common trunk.	33 %	36 %
Type VII (G)	The lateral accessory saphenous vein and superficial epigastric vein drained into great saphenous vein by a common trunk.	2 %	--
Type VIII (H)	The Lateral accessory saphenous vein and superficial circumflex iliac vein drained into the Great saphenous vein by a common trunk.	8 %	--

Chart No 4
Drainage Pattern at Great Saphenous Vein



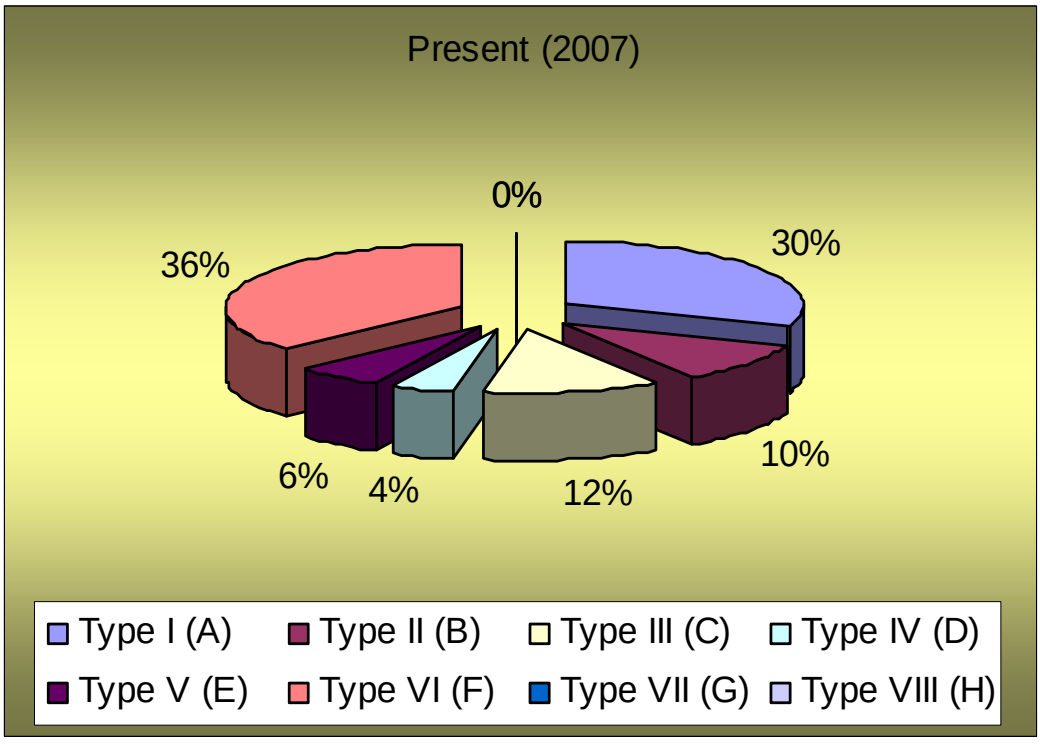


Table – 30

DRAINAGE PATTERN OF SAPHENO-FEMORAL JUNCTION IN COMPARISON WITH CHUN ET AL (1992)

Drainage of Accessory Medial Saphenous Vein:

S. No:	Pattern	Chun et al	Present
1	Directly	82.3 %	94 %
2	In common	17.7 %	6 %

Drainage of Accessory Lateral Saphenous Vein:

S. No:	Pattern	Chun et al	Present
1	Directly	67.1 %	50 %
2	In common	32.9 %	50 %

Drainage of Superficial circumflex iliac vein:

S. No:	Pattern	Chun et al	Present
1	Directly	83.1 %	40 %
2	In common	16.9 %	60 %

Drainage of Superficial epigastric vein:

S. No:	Pattern	Chun et al	Present
1	Directly	77.1 %	50 %
2	In common	22.9 %	50 %

Drainage of Superficial external pudendal vein:

S. No:	Pattern	Chun et al	Present
1	Directly	95.2 %	90 %
2	In common	4.8 %	10 %

Table – 31

RELATIONSHIP OF EXTERNAL PUDENDAL ARTERY TO SAPHENOUS VEIN IN COMPARISON WITH STUDY OF DONNELLY (2004):

S.No:	Relationship of EPA	Donnelly (2004)	Present (2007)
1	EPA not visualized	73.1 %	74 %
2	EPA Anterior to saphenous vein	16.8 %	10 %
3	EPA Anterior to SFJ	1.1 %	--
4	EPA Posterior to saphenous vein	4.6 %	16 %

Table – 32

RELATIONSHIP OF SAPHENOUS NERVE TO SAPHENOUS VEIN IN COMPARISION WITH HOLME'S STUDY (1988):

S.No:	Types	Holme (1988)	Present (2007)
1	Type I	68 %	68 %
2	Type II	16 %	12 %
3	Type III	11 %	18 %
4	Type IV	3 %	2 %

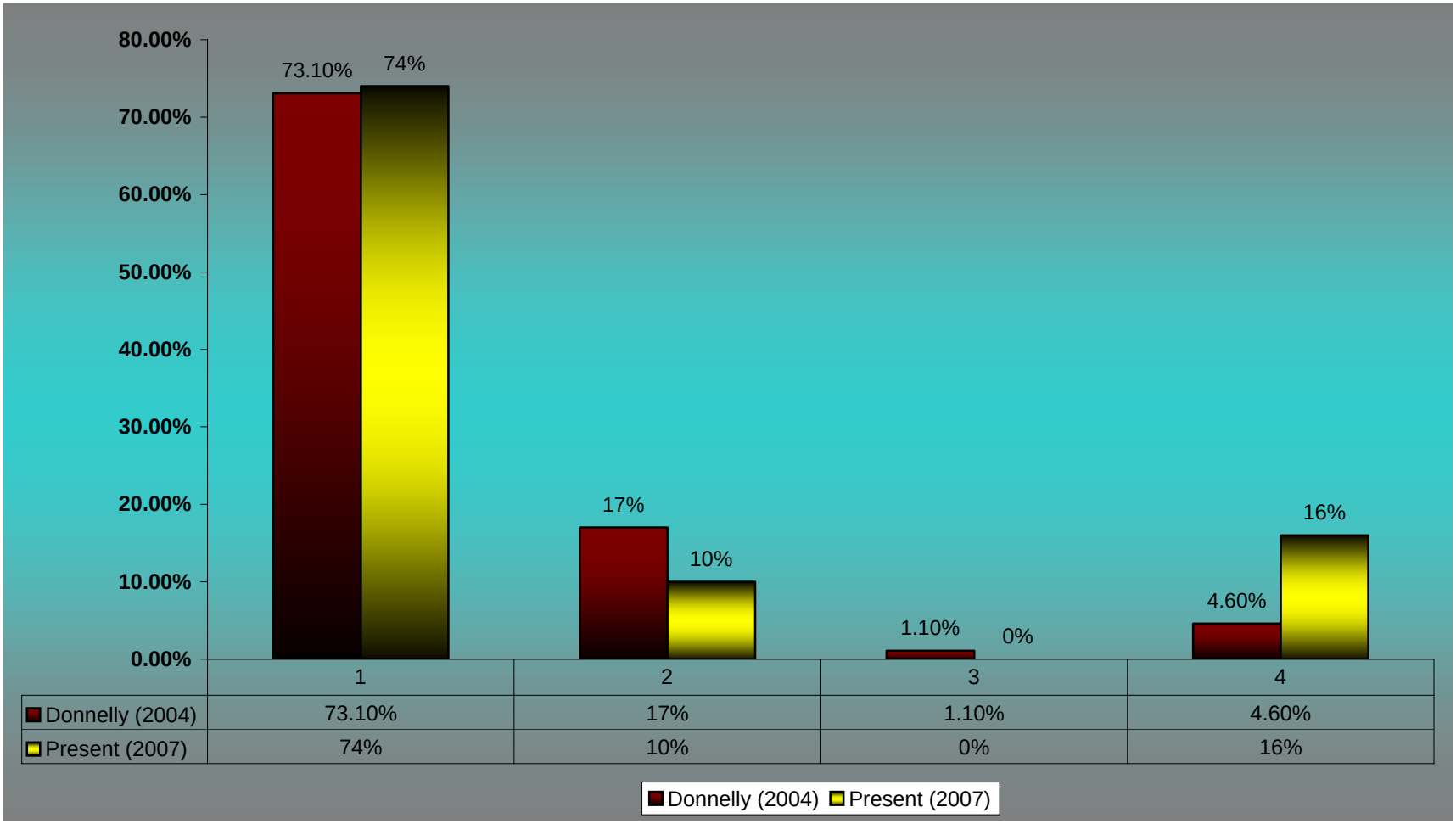
Table – 33

PERFORATORS IN THIGH AND LEG

S.No:	Author	No. Perforators in Thigh	No. Perforators in Leg
1	Charles Kosinski	1 – 2	4
2	John Bruce	1	4
3	Ernest Gardener	1	4
4	George.A.Piersol	1	8
5	Sherman	1 – 6	6
6	Present Study	1 – 2 Average 1.14	1 – 4 Average 2.4

Chart No. 5

RELATIONSHIP OF EXTERNAL PUDENDAL ARTERY TO SAPHENOUS VEIN IN COMPARISON WITH STUDY OF DONNELLY (2004).



	1	2	3	4
Donnelly (2004)	73.10%	17%	1.10%	4.60%
Present (2007)	74%	10%	0%	16%

Table – 34

NUBMER OF VALVES.

Author	No: of Valves
Klotz (1887)	6 – 25
Kampmeis and Birch (1927)	6 – 14
George A. Piersol (1930)	12 – 18
Buchannan (1953)	15
Morris (1953)	6 – 18
J. C. B. Grant (1957)	8 – 20
Russel T. Woodburne	10 – 20
Wgalmsely. James A. Ross	8 – 10
G. J. Romanes (1964)	15
Shinohara. M	3 – 11
Hen. Gray (1995)	10 – 20